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THE WORLD'S FAIR BUILDINGS THROUGH FRENCH SPECTACLES.

By Jacques Hermant.

THE portico constituting the entrance to the Chicago Exposition recalls in its proportions that superb Corinthian ordonnance which so majestically precedes the grand basilica of the capital of the Christian world; the two pavilions which terminate it are indisputably and by far the best studied works among those that seek their inspiration in ancient art and that of the Renaissance. But why are the balustrades which crown the whole surmounted by a profusion of statues whose outline is as complicated as uninviting and which seem ready to lose their balance in the winds of a seldom placid lake?

And especially why this little triumphal arch which the monumental proportions of the portico render still more insignificant, when one would have fancied rather the Marine Gate of the Exposition covered by some gigantic arcade worthy of that America which hesitates at nothing?

Indeed, would it not have been much better to frankly interrupt the portico, thus giving a free view of the infinite horizon of the lake which everywhere it seems to have been the aim to hide, as if Chicago were ashamed of this sea which is not a sea? After all, perhaps it was the intention that nothing should distract the visitors' attention from the spectacle prepared for them. Perhaps there was some fear of that peculiar attraction which the sight of immensity so exercises upon our eyes that we fix them obstinately upon it and cannot take them off. And then, however vast the work of man, would it not have seemed somewhat petty beside that of nature?

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But, say what we may of its situation, the peristyle preceding the Exposition on the lake shore is none the less one of the best works, if not the best, that we shall find there. It does great honor to its author, Mr. C. B. Atwood of Chicago, to whom we award this eulogy with the more pleasure from the fact that we must elsewhere find him guilty of a plagiarism hardly pardonable in a man of talent.

To the right of the entrance the Manufactures building stretches almost to the limit of vision the mass of its immense nave, as broad as the Machinery Hall at Paris, of which it is but a somewhat unhappy imitation, and more than sixty feet higher, surrounded by aisles whose exterior façade offers a monotonous succession of very simple arcades broken at the axes and the corners by pavilions which are literal reproductions of the triumphal arches of old Rome.

Here not the slightest effort at imagination or at composition, not a new idea; the entire building is a copy, from the decoration of the tympana of the arches to the socles of the pillars of the balustrade.

We will not dwell upon the interior, which, of all the World's Fair buildings, is certainly that which is arranged with the least regard for the exhibitors, or upon that unlucky gallery, situated hardly twenty feet above the ground floor, which casts its unfortunate shadow over all the aisles and compels the use of the electric light at noonday. This building has been condemned by all those who have been invited to locate in it, and we believe that it proves for the second time and definitively that the system of colossal naves is absolutely unfavorable to the exhibition of products, especially those of the industrial arts. Their use should be reserved for railway stations, where they are much more in place.

Mr. George B. Post of New York aimed to amplify and adorn the Paris Machinery Hall, but he produced only a Palais de l'Industrie almost as great a failure as its ancestor in the Champs-Élysées.

Back of the Manufactures building—that is, after crossing the right arm of the canal—lie the Electricity and Mining buildings, each treated in a mongrel style of architecture, inspired by the Roman Baths and the Italian Renaissance.

In the Electricity building Messrs. Van Brunt and Howe of Kansas City have specially applied themselves to the achievement of an outline full of motion; they have tried to render their

architecture as light as possible, as well within as without. The gables which terminate the roof of the central nave in the form of a Greek cross are flanked by two square pylons supporting windowed campaniles, which give the whole an aspect of an Italian church of the seventeenth century. At the corners similar pylons surmounted by similar campaniles occur again to cut the outline and disconcert the eye, which has hardly been prepared by the very calm and restful lines of the lower ordonnance for such an abundance of pinnacles and spires.

In opposition to his neighbors, who are to be credited with a certain lightness of hand, Mr. S. S. Beman of Chicago, to whom fell the task of housing Mines and Metallurgy, suffered himself to be carried a trifle far in that expression of power which, it is true, befits his subject. In his architecture one plainly feels the heavy hand of iron which extends over modern German art and covers with a veil of sadness and oppression the works of the most brilliant artists.

At the left of the entrance, and corresponding to the three edifices of which we have just spoken, are located the Agriculture and Machinery buildings. Two more great palaces, the first of which is symmetrical with the Manufactures building, while the second covers a surface equal to the combined areas of the Electricity and Mining buildings and the passage between them.

The Agricultural building, the work of Messrs. McKim, Meade & White of New York, offers in its wealth a very curious contrast with its vis-à-vis. Whereas the Manufactures building is characterized by monotony and the straight line, in the Agricultural building movements, flights, and complication seem to have been particularly sought.

As a point of departure, again Rome, always the Baths.

At the center a portal surmounted by an attic and a pediment, back of which rises a dome in the shape of a depressed calotte ; at the corners large massive pavilions connected by a series of nine arcades interrupted at intervals of three by pylons profiling even in the cornice. Over all these flights, which in themselves cut, agitate, and even slash the façade, a profusion of groups : bellowing cattle, prancing horses held in hand by winged figures, eagles, women scattering flowers and crowns in space, all actively standing out against the sky, at disturbing heights, in a manner more disorderly than decorative.

Here, however, it is not the architects alone that are to

blame. At most they can be accused, knowing as they do the inexperience of American sculptors, of having left to these so fine a share.

Over the landings, bridges, and stairways are scattered groups of animals and figures of astonishing *naiveté* and pretension. The animal sculptors especially seem to have taken as their decorative ideal the stuffed specimens in anthropological museums, and it is a painful surprise to meet at every turn these bears, tigers, elks, or buffaloes as thin as though they had been wandering for months in the Pampas.

It would be an injustice nevertheless not to give flattering mention to Mr. Macmonnies, whose monumental fountain—perhaps a little too closely related to that of Coutan in the Champ-de-Mars—contains bits that are superb.

At the left of this vast composition we find Machinery Hall, which is certainly one of the most interesting buildings of the World's Fair.

Messrs. Peabody & Stearns of Boston have given much study to the Spanish Renaissance; perhaps, in the decoration of their corner cupolas, they have even remembered too vividly its complex riches and its love of detail. But we can only praise without reserve their grand entrances, standing out against broad bare surfaces that rest the eye and lead it without effort to the two windowed campaniles whose sharp spires point delicately skyward and support light figures which, without contortion, spread their wings and seem ready to fly away into infinity.

The general ordonnance of the façade consists of a simple Corinthian corridor surrounding the whole building, whose ground-floor pierced by vigorous arcades offers a proper contrast to the delicacies of the upper story. All shows the artistic sense; fine in its detail, it is not on too large a scale, and it certainly would gain by not being in the vicinity of the enormities that surround it.

We have not yet spoken of the Dome, that isolated cupola in the broad esplanade which extends back of the central sheet of water, from the monumental fountain to the principal railway station. Here we must sincerely confess our embarrassment.

We have no longer to deal with an unknown, we are confronted with the work of a master, of a man who has contributed more than any other to the development of architecture in America during the last half-century and who is known not only by his works but by his love for France, where he studied. We should

like to speak of Mr. Richard M. Hunt of New York with the same frankness that we have shown in the preceding pages, and we fear that our respect and the affection that many of us bear him do not leave us quite at liberty.

This capital work which by its height dominates the whole of Jackson Park bears lofty testimony to the science and skill of its creator. Here there is no awkwardness to shock, no faults of detail to betray the architect's inexperience. All is poised, in perfect equilibrium. Each part is learnedly studied; the curve of the dome is felicitous, and its brilliant decoration offers at certain points analogies (though distant) with the Dôme des Invalides; it would be difficult, indeed, to formulate a precise criticism. Why, then, is the eye not satisfied?

In our view it is because the point of departure is bad. To make of the Administration building a dome superior in its proportions to those of the Pantheon simply because it was expected that fêtes were to be given there (though, in fact, they were never given) was to force the departmental offices back into the annexes, which therefore had to be extended in order to afford sufficient room. Hence the four corner pavilions which were intended to support the central portion of the structure, but which really so crush it that its axial entrances seem to be at the extremity of a cul-de-sac. Moreover, the basements are thereby given such importance and vertical development that the lofty colonnade surrounding the dome does not properly subordinate them.

Must we blame the artist who was thus asked to solve an impossible problem? We think not, and we are even of the opinion that there are few among the cleverest who would have met the difficulty more successfully.

The only criticism which it seems to us possible to pass upon him relates to the upper part of the cupola. Why not have terminated it by a campanile, a pinnacle, a top of some sort, to arrest the line and emphasize the summit? One cannot help feeling a strange sensation of incompleteness, which all the reasoning in the world fails to explain.

If this is an attempt to depart from precedent, Mr. Hunt must excuse us for telling him frankly that it is not a happy one.

It would tire the reader were we to pass in review one after another the innumerable minor structures that rise in every direction,—State buildings, pavilions of foreign nations and of certain large manufacturers, Austrian, German, Irish, Turkish, Dahome-

yan, and other villages, covering the immense area of the park, in which a crowd of 700,000 people can circulate with ease. Therefore we will simply point out in passing the beautiful glass cupola of the horticultural exhibition, whose author, Mr. V. L. B. Jenney, has improved his opportunity in an excellent fashion, though his work is somewhat marred by the bad proportions of the entrance pavilions and the deplorable execution of a frieze in bas-relief, as high as the arcades which it crowns.

We must not fail, however, to recognize the Art Gallery which all the pupils of the École des Beaux-Arts have seen pass before their eyes in the collection of Grands Prix de Rome, and whose literal copy, due to Mr. C. B. Atwood, is perhaps a flattering tribute to French superiority in architecture, but does little honor to the imagination of the artist who could compose the peristyle of which we have already spoken.

And now we come to the two works which are indisputably the most original of all and which attract the most attention from those who seek new manifestations.

We refer to the Transportation and the Fisheries buildings.

The Transportation building, the work of Messrs. Adler & Sullivan, abruptly breaks the monotony of whites and throws into the ensemble a note of violent color which in itself alone would suffice to draw the attention of all.

Let us say at once that they lose nothing thereby, and that the ingenuity of the decoration merits the attention which we give it at first in spite of ourselves. Imagine a long bare wall pierced by arches without molding, crowned by a high projecting square flagging ornamented on its face by one of those ingenious friezes of foliage which are, so to speak, the personal mark of Sullivan. The entire façade is painted in a very vigorous red, serving as a background against which stand out ornaments in which yellows and greens prevail, of manifestly Oriental inspiration, but frankly modernized by two men of talent, Messrs. Healy and Millet, decorative painters, who are already famous in Chicago through numerous works of the greatest interest.

Above this ornamentation appear large winged figures, of a primitive manner, symbolizing in a very unexpected way the genii of Science.

At the middle of the building opens the Golden Doorway, conceived in the same spirit. It has faults, but, in spite of them, one cannot refuse to recognize it as a work of very great imagination

in its detail, of a boldness of composition that is perhaps excessive and of an originality that fearlessly declares itself.

To take a tunnel entrance as the starting-point of the principal doorway of the Transportation building and to treat it so freely and roughly that the initial idea remains sufficiently manifest; to devise for its decoration a series of ornaments brilliant enough to give it astonishing wealth without in the least detracting from the savagery of the lines; to dare to face the whole with a metallic patina of gold and silver which gives it the appearance of a gigantic specimen of the goldsmith's art,—this is not commonplace.

It is not perhaps in the best taste; it is neither very pure nor very logical; but, amid the old arsenal of columns and pediments reconstructed by the authors of the works which we have just reviewed, it would be unjust not to devote special attention to this attempt of artists desirous of quitting the beaten paths.

Very interesting also from the same point of view, but distinguished by qualities of a different order, is the Fisheries building.

Mr. Henry Ives Cobb, of Chicago, is not as uncompromising an innovator as his two fellow-citizens; he does not seek those violent contrasts of lines and colors of which they are fond; he has none of those audacities which are hardly to be indulged except by a certain contempt for the arrangement of details.

Here we are in presence of a delicate and curious inquirer who wishes to impart his personal note to the most intimate portions of his composition, but whose first care is to shock nobody.

The Fisheries building is composed of a central structure in which are exhibited the technical parts of the exposition, the products and appurtenances of fishing. This structure is connected by a slightly curved corridor with two circular pavilions in which are placed superb aquariums containing fish of the most various and varied species. A crowd continually presses before this marvelous exhibition of animals of the strangest forms that move about gracefully amid the marine plants so dear to them in large glass tanks affording them perfect liberty of motion.

But, after having admired them at length, it is not without a certain astonishment that this crowd halts at the exit before the façade of the building and there again discovers, sporting in the capitals, winding along the columns, and entwining to form balusters, all this marine fauna and flora which it has just viewed in actual life.

The façade in itself has the requisite unity and simplicity. A sort of cloister formed of an infinity of little arcades borne on small columns envelops it with its firm and delicate lines and is repeated above the roof to again surround all the upper portion. The appearance is like that of those beautiful convents of the days when Italy, stubbornly resisting Gothic art, had not yet found its way back to ancient Rome and was living under the influence of Lombardic and Byzantine memories.

But, however interesting in itself, the general architecture of the building is nothing beside the details for which it gives a pretext. The capitals and columns have received each a different decoration, composed of marine plants, fishing appurtenances, fish whose odd forms have served to supply most unexpected *motifs*, each happier than the other, of an originality that charms and a variety that surprises.

One little expected to find here such an outburst of skill and such knowledge of arrangement coupled with a taste so sure.

Mr. Ives Cobb is an artist who is master of himself, and we salute him the more willingly because, to any one who has been willing to follow attentively this long chat upon architecture in the United States, it is unhappily certain that there are still in America more men who consider it as a profession than as an art.

But let us be careful ; here and there already are to be found some temperaments more solidly tempered than the rest, which offer victorious resistance to that sort of depression of the brain caused by the exclusive pursuit of money. Perhaps it is at the very moment when those who are so furious in the contest for its possession feel all their treasures escaping them in consequence of the depreciation of metal that is to begin in America, not the Renaissance, but the Naissance of an art which must be the direct resultant of all that Europe knows and all that those of her children desire who have gone across the Atlantic in search of the liberty which they lacked and the room which they no longer found.—*Gazette des Beaux-Arts.*

SHIPS OF THE NEW BRITISH NAVY.

By W. Laird Clowes.

THE new navy of Great Britain, so far as its ironclad battleships are concerned, may be said to date from the time of the construction of the first vessels of what is known as "the Admiral class." This class, comprehending six ships that bear the names of distinguished British admirals, was launched between 1882 and 1886, inclusive, and was designed under the superintendence of Sir Nathaniel Barnaby. Since then we have seen launched two battleships of the *Sans Pareil* class (1887), two of the *Trafalgar* class (1887-88), seven of the *Royal Sovereign* class (1891-92), one of the *Hood* class (1891), and two of the *Centurion* class (1892); and we have begun to build one of the *Renown* class and two of the *Majestic* class.

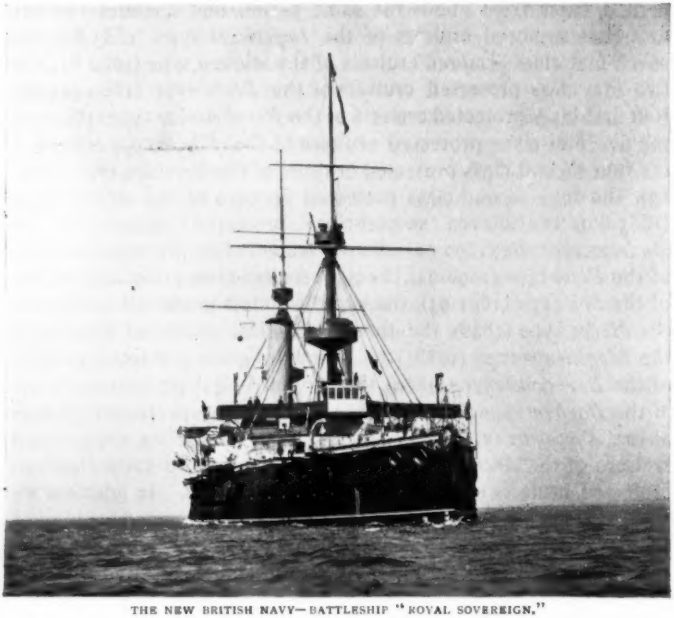
The new navy of Great Britain, so far as its cruisers are concerned, dates from about the same period, and includes the two first class armored cruisers of the *Imperieuse* type (1883-84), the seven first-class armored cruisers of the *Aurora* type (1886 87), the two first-class protected cruisers of the *Blake* type (1889-90), the four first-class protected cruisers of the *Royal Arthur* type (1891-92), the five first-class protected cruisers of the *Edgar* type (1890-92), the four second-class protected cruisers of the *Arethusa* type (1882-83), the four second-class protected cruisers of the *Mersey* type (1885-86), the eleven second-class protected cruisers of the *Andromache* type (1890-92), the ten second-class protected cruisers of the *Pique* type (1890-92), the eight second-class protected cruisers of the *Fox* type (1891-93), the two third-class protected cruisers of the *Medea* type (1888), the three third-class protected cruisers of the *Magicienne* type (1888), the four third-class protected cruisers of the *Barracouta* type (1889), the two third-class protected cruisers of the *Barham* type (1889-90), the nine third-class protected cruisers of the *Katoomba* type (1889-90), the seven third-class unprotected cruisers of the *Archer* type (1886-87), and the two third-class unprotected cruisers of the *Fearless* type (1885-88). In addition we have, still under construction, two first-class protected cruisers of the *Powerful* type and three second-class protected cruisers of the *Minerva* type.

As for craft of miscellaneous character, I have to catalogue

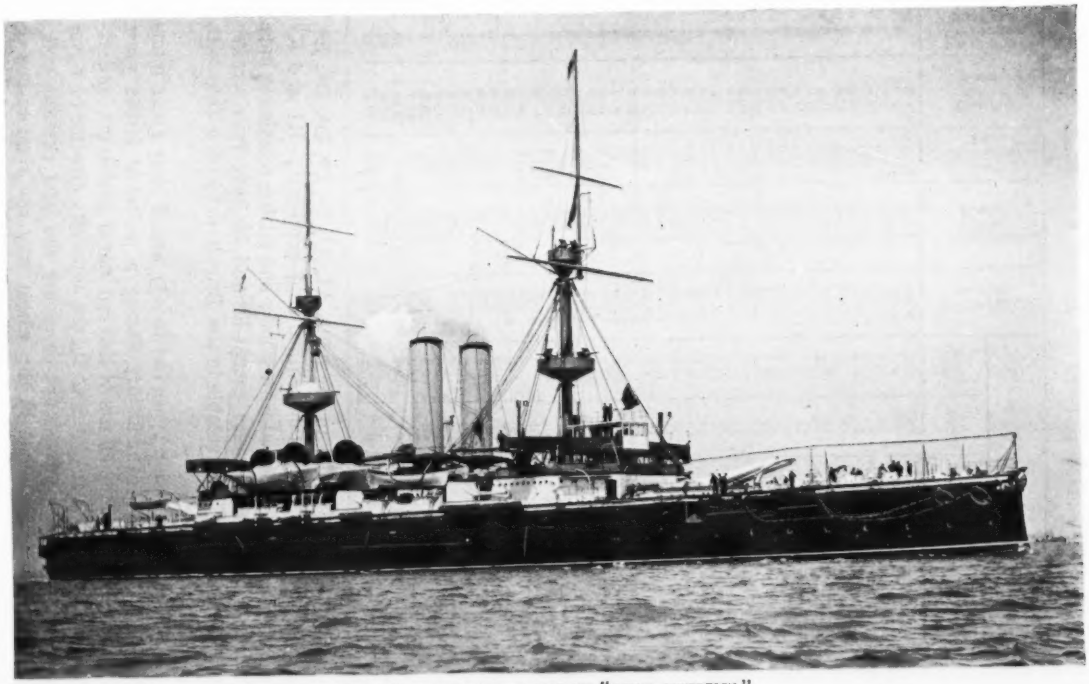
the torpedo-depôt ship *Vulcan* (1889), the ram *Polyphemus* (1881), three torpedo gunvessels of the *Grasshopper* type (1886-87), the torpedo-gunvessel *Rattlesnake* (1886), the eleven torpedo gunvessels of the *Sharpshooter* type (1888-90), the eleven torpedo gunvessels of the *Antelope* type (1891-93), the five torpedo gunvessels of the *Dryad* type (1893-94), the six "station" gunboats of the *Partridge* type (1888), the nine "station" gunboats of the *Goldfinch* type (1889), the eighteen first-class torpedo boats numbered from 79 to 97 inclusive (1886-94), and forty two torpedo boat-destroyers (most of which are still in early stages of construction) of the *Havock* and kindred types. To these may be added two "station" gunboats of the *Alert* type, which are being built.

The general details of the various types above mentioned are thrown into tabular form on a succeeding page in order to save space and facilitate reference.

A few other modern ships which I might include are omitted, as they possess few if any characteristics, save their armament, to distinguish them from vessels of older type.



THE NEW BRITISH NAVY—BATTLESHIP "ROYAL SOVEREIGN."



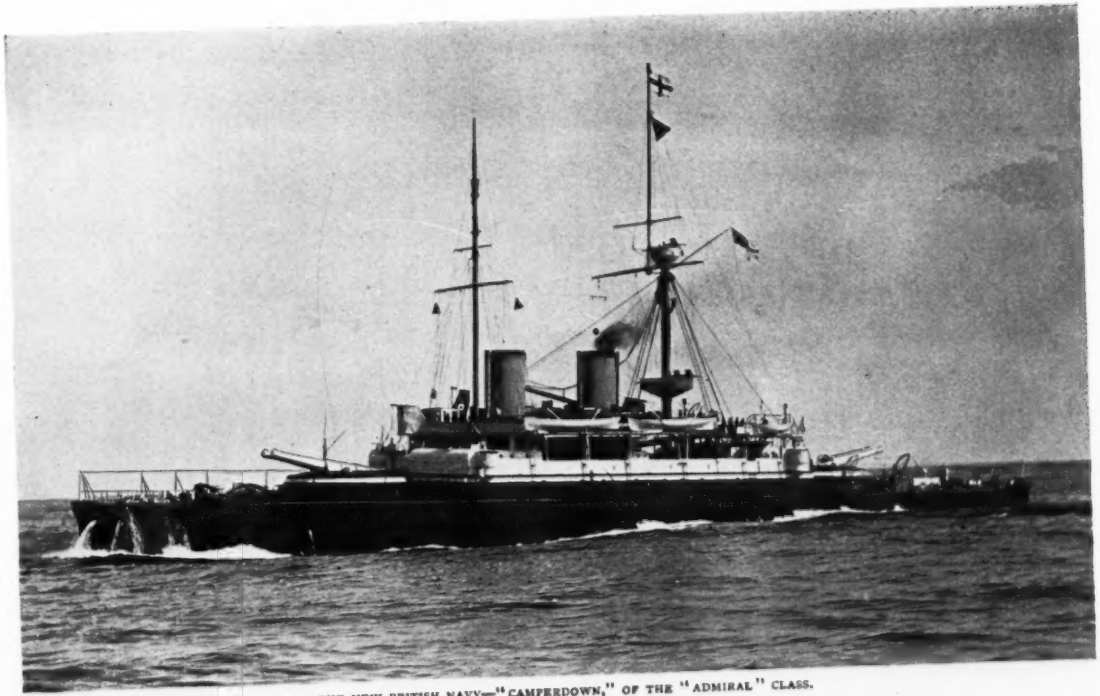
THE NEW BRITISH NAVY—BATTLESHIP "ROYAL SOVEREIGN."

PRINCIPAL DETAILS OF BRITISH WAR-SHIPS.

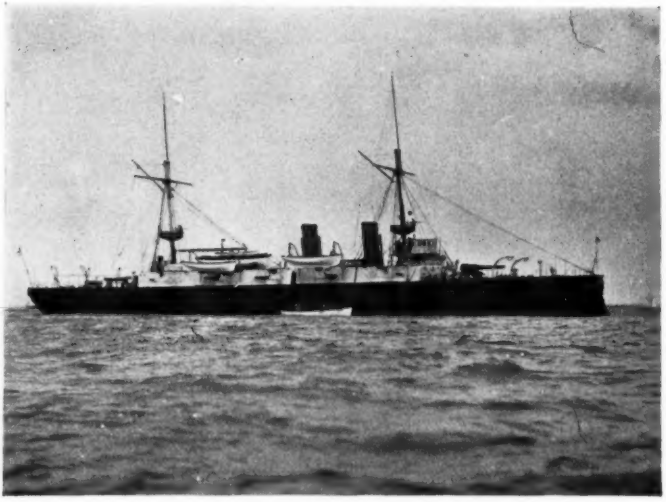
Type.	Dimensions in Feet.			Displacement in Tons.	Indicated Horse Power.	Coal Capacity Tons.	Contract Speed Knots.	No. of Ships Composing the Type.
	Length.	Beam.	Mean Draft.					
A 1 "Admiral"	325	68	25.8	9,500	9,500	900	16.5	6
"	330	68.5	27.8	10,600	11,500	750	16.7	
A 2 Sans Pareil	340	70	26.8	10,470	14,000	750	16.7	2
A 3 Trafalgar	345	73	27.5	11,940	12,000	900	16.7	2
A 4 Royal Sovereign	380	75	27.5	14,150	13,000	900	17.5	7
A 5 Hood	380	75	27.5	14,150	13,000	900	17.5	1
A 6 Centurion	360	70	25.5	10,500	13,000	750	18.2	2
A 7 Renown	380	72	26.9	12,350	12,000	800	17.0	1
A 8 Majestic	390	75	27.5	14,900	13,000	900	17.6	2
B 1 Imperieuse	315	62	27.3	8,400	10,000	900	16.7	2
B 2 Aurora	300	56	22 8	5 000	8,500	900	18.5	7
C 1 Blake	375	65	25 9	9,000	20,000	1 500	22 0	2
C 2 Royal Arthur	360	61	24.7	7,700	12,000	850	19.5	4
C 3 Edgar	360	60	23.7	7,350	12,000	850	19.7	5
D 1 Arethusa	300	46	19.0	4,300	5,000	1,000	17.0	4
D 2 Mersey	300	46	18.0	4,050	6,000	750	18.0	4
D 3 Andromache	300	43	16.5	3,400	9,000	400	20 0	11
D 4 Pique	300	43.7	17.5	3,600	9,000	400	19.7	10
D 5 Fox	320	49.5	19 0	4,360	9,000	400	19 5	8
E 1 Medea	265	41	16.5	2,800	9,000	400	20.0	2
E 2 Magicienne	265	42	17.5	2,950	9,000	400	19.0	3
E 3 Barracouta	220	35	14.0	1,580	3,000	160	16.5	4
E 4 Barham	280	35	13.2	1,830	6.000	140	19 5	2
E 5 Katoomba	265	41	15.5	2,575	7.500	300	18 2	9
E 6 Archer	225	36	13.5	1,770	3,500	250	17 0	7
E 7 Fearless	224.5	34	13.5	1,580	3,200	250	16.7	2
C 5 Powerful	340	70	27.0	14,000	25.000	3,000	22 0	2
D 6 Minerva	350.2	53	20.3	5.500	9,600	550	19 5	3
F Vulcan	350	58	23.0	6,630	12,000	1,000	20 0	1
G Polyphemus	240	40	20.0	2,640	5,500	200	17·0	1
H 1 Grasshopper	200	23	8.0	525	2,700	100	19·0	3
H 2 Rattlesnake	200	23	8.0	550	2,700	100	18 5	1
H 3 Sharpshooter	230	27	8 2	735	3,500	100	19 2	11
H 4 Antelope	230	27	8.8	810	3.500	100	19·0	11
H 5 Dryad	250	30.5	9.0	1,070	3.500	100	19·0	5
K 1 Partridge	165	29	11.3	755	1,200	105	13 2	6
K 2 Goldfinch	165	31	11.6	805	1,200	105	13 7	9
M Torpedo-boats	135 to 150	14 to 17.5	5.5 to 6	105 to 130	1,100 to 2,000	20 to 35	20 to 24	18
N Havock	180	18.5	5.0	215	3,300	60	26.5	42
K 3 Alert	180	32 6	11.6	960	1,400	130	13.2	2

Of the classes noted in the table, A^6, A^7, B^1, C^2, D^4, D^5, E^2, C^5, D^6, and K^3 are wood-sheathed and coppered; K^1 and K^2 have steel frames planked with wood; and all the remainder have steel hulls. All the classes except K^2 and M have twin screws; but there is as yet no example in the British navy of a ship with triple screws.

The eight battleship types (A^1 to A^8) are of very great interest. They represent the history, during a period of fifteen years or thereabouts, of the efforts of English naval architects, and especially of Dr. W. H. White, C. B., the admiralty director of naval construction, and his assistants, to secure the best possible compromise and to reconcile in the wisest way the rival claims of heavy guns and heavy armor, size and speed, radius of action, and



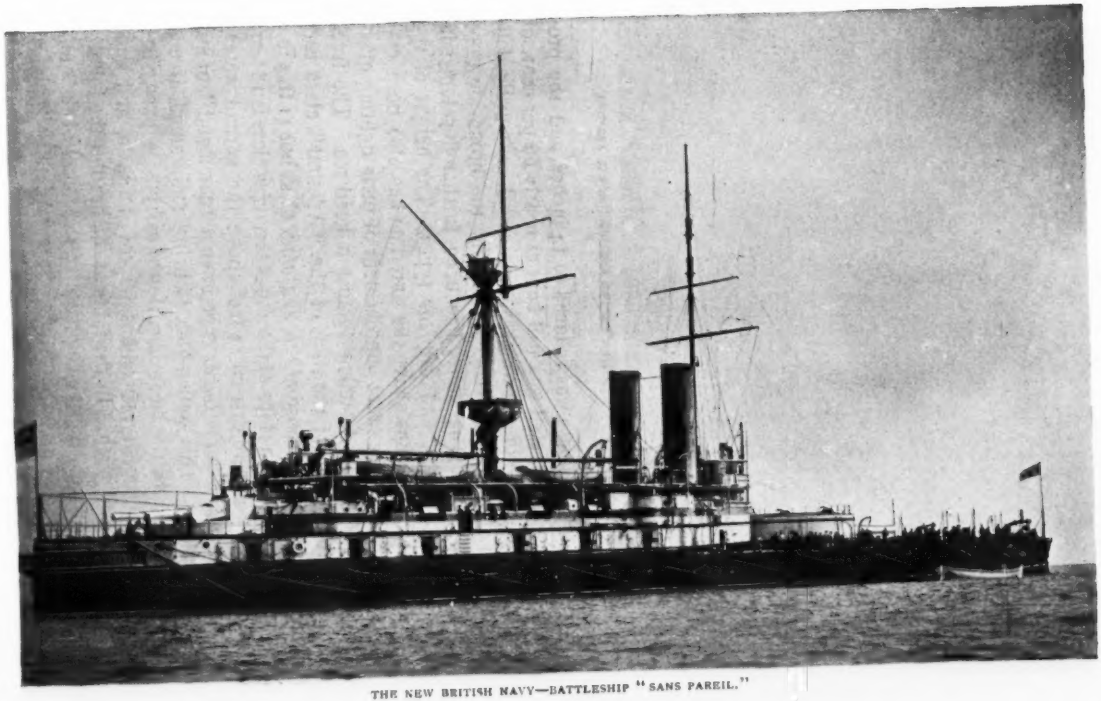
THE NEW BRITISH NAVY—"CAMPERDOWN," OF THE "ADMIRAL" CLASS.



THE NEW BRITISH NAVY—FIRST-CLASS ARMORED CRUISER "AURORA."

displacement, elevation of main battery and stability at sea, protection and habitableness in peace-time, and a hundred other pairs of conflicting factors; and I venture to think that most of the decisions which appear to have been arrived at and embodied in the designs are thoroughly defensible. It has been recognized, on the one hand, that no thickness of armor capable of being carried on the sides of a ship of practicable dimensions will keep out all the projectiles that can be hurled against it, and, on the other hand, that so long as a given gun will at moderate range easily pierce any armor now afloat, it is, comparatively speaking, wasteful to employ a heavier gun. Both armor-thickness and gun-weights, therefore, have been reduced, while the total area of armored surface and the total number of medium-calibered guns have been increased. In the eight successive types of battleship classes the calibers of the heaviest guns have been, in chronological order, 16.2 in., 16.2 in., 13.5 in., 13.5 in., 13 5 in., 10 in., 10 in., and 12 in.

In the "Admiral" class the armored belt, though 18 inches in thickness, extended along only a little more than 45 per cent. of the ship's length. In the *Trafalgar* type the armored belt, 20 inches thick in some places, but only 14 in others, was extended along more than 66 per cent. of the ship's length. In the *Royal Sovereign*



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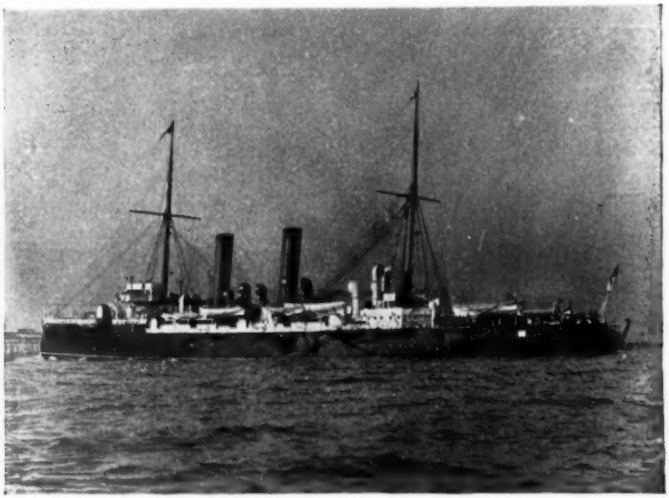


THE NEW BRITISH NAVY—FIRST-CLASS PROTECTED CRUISER "ROYAL ARTHUR."

type the general thickness was reduced to 14 inches, and the proportion of length protected was still kept at nearly 66 per cent. of the whole, while some of the weights thus saved were utilized in the formation of armored casements around the broadside guns on the battery deck. The policy has been further developed in the *Centurion*, *Renown*, and *Majestic* types. The height of the muzzles of the heavy guns above the waterline has also been materially increased, to the great improvement of their fighting qualities when the ships are steaming against a head sea. The freeboard, forward and aft, of the ships of the "Admiral" class was only 10 ft. 3 in., and of those of the *Trafalgar* class but 11 ft. 3 in.; but the freeboard of the ships of the *Royal Sovereign* class is 18 feet, and their heavy guns are carried 23 feet above the normal waterline, while those of the *Trafalgar* type have a "command" of no more than 15 feet. This policy also is being maintained, if not further developed. In the meantime, if coal carrying capacity has remained nearly stationary, speed has improved a little, and gun-power has improved much. In the table at the head of the following page is given an instructive comparative statement of the guns and gun-power of the *Camperdown* (one of the "Admirals") and of the *Majestic*:

H. M. S. "CAMPERDOWN."

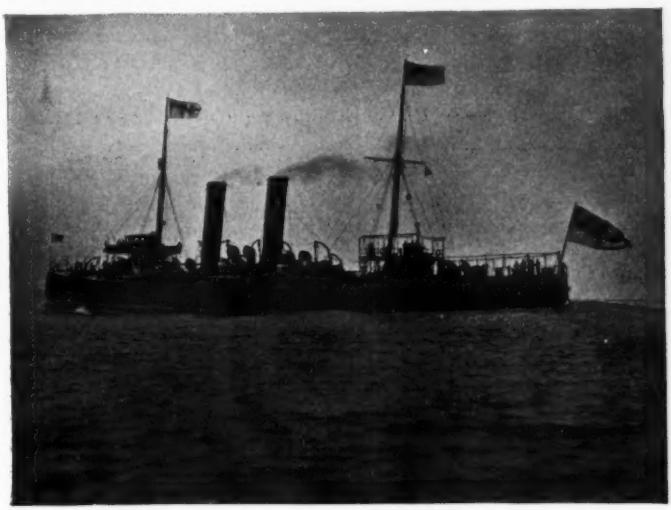
No.	Guns.	Total Weight of Guns. Tons.	Total Muzzle Energy of Guns. Ft. tons.	Muzzle Velocity per Gun. Ft secs.	Perforation of wrought iron at 1000 yds. per Gun. Inches.
4	13.5-in. R. B. L.....	268	140,920	2,016	28 2
6	6-in. R. B. L..... ...	30	15,990	1,960	10 5
12	6-pr. 2 24-in. R. F.....	4.8	1,650	1,810	2 5
7	3-pr. 1.85-in. R. F.....	1.7	562	1,873	1.8
29		304.5	159,122		

H. M. S. "MAJESTIC."

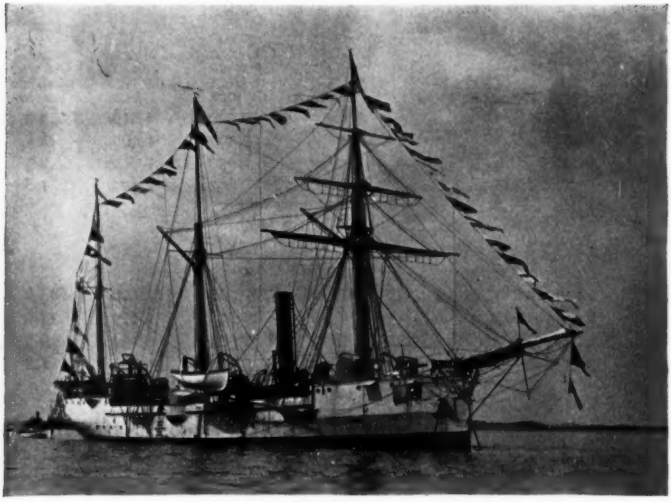
4	12-in. R. B. L.....	*200	*100,000	*2,100	*23.0
12	6-in. R. F.....	76	40,272	2,200	14.0
16	12-pr. 3-in. R. F.....	8	6,304	2,133	6.3
12	3-pr. 1.85-in. R. F.....	3	963	1,873	1.8
44		287	147.539		

* Approximate.

Thus, while a saving of about 5.5 per cent. has been effected in the weight of guns carried, the number of guns carried has been increased by about 51 per cent., and the total muzzle-energy developed has been diminished (even assuming the moderate esti-



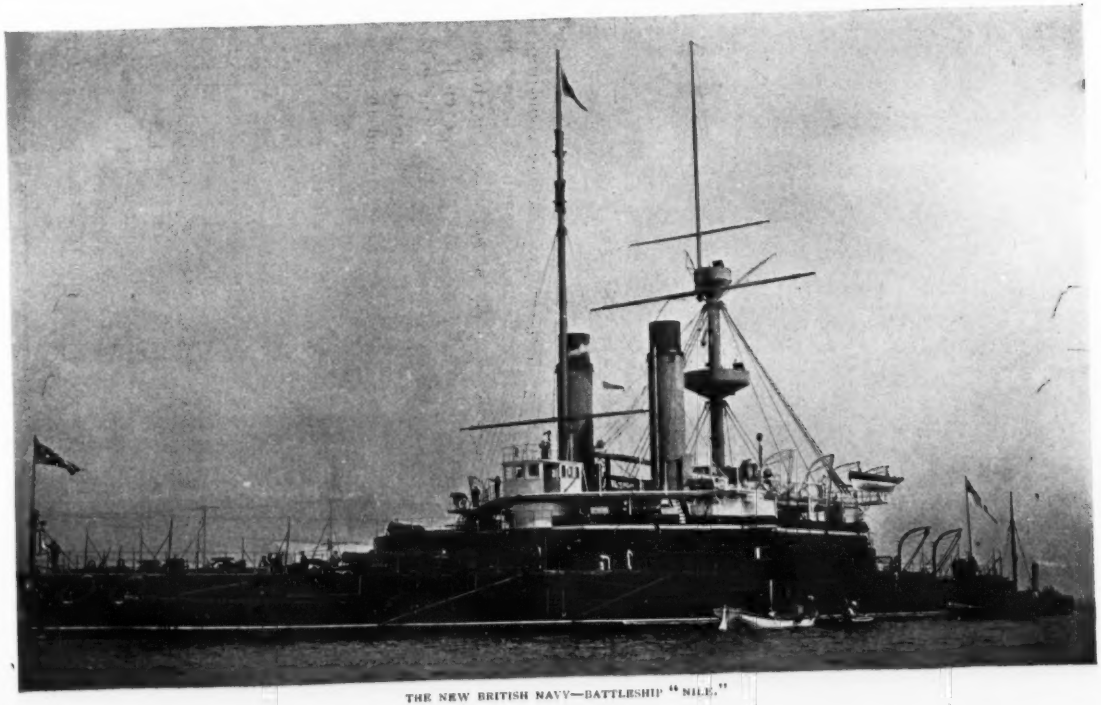
THE NEW BRITISH NAVY—SECOND-CLASS PROTECTED CRUISER "INDEFATIGABLE."



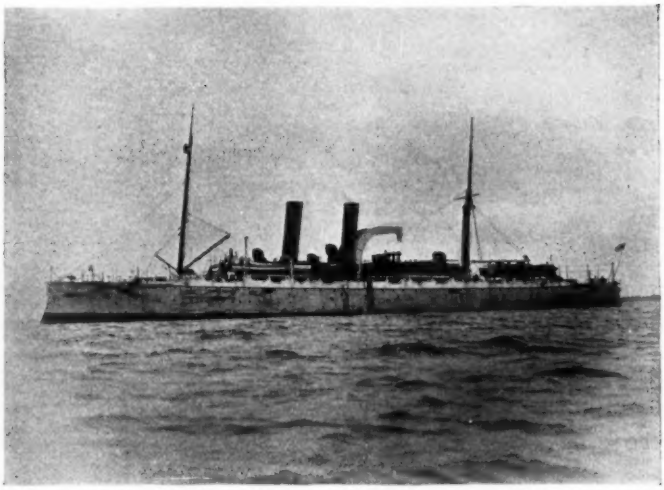
THE NEW BRITISH NAVY—STATION GUNBOAT "PIGMY."

mate for the new 12-inch guns not to be exceeded) by little more than 7 per cent. There can be no question, especially when one reflects how much greater a weight of metal the *Majestic* can discharge in a given time, that she is a far more offensively powerful ship than the *Camperdown*.

But, powerful, spacious, fast, and magnificent though the new British battleships undoubtedly are, it unfortunately must be admitted that they possess some by no means trifling faults, and first among these is the fault of being very indifferent gun-platforms. I have more than once seen ships of the *Royal Sovereign* type at sea with a fleet, and I have invariably remarked that they roll more freely than any other vessels in company. Excessive rolling is a defect which may, and in this case does, coexist with perfect safety so far as stability is concerned; but in a battleship it is none the less a defect. We have, ere this, fought fleet actions as well as single-ship actions in a heavy sea with a gale of wind blowing. The weather was all that was abominable when Sir Edward Hawke defeated M. de Conflans in 1759, and a situation of the same kind may easily occur in the next naval war. The *Royal Sovereign*, the *Empress of India*, the *Ramillies*, and the *Resolution*—all ships of type A^4—roll between 30 and 40 degrees each way on very mod-



THE NEW BRITISH NAVY—BATTLESHIP "NILE."



THE NEW BRITISH NAVY—TORPEDO-DEPOT SHIP "VULCAN."

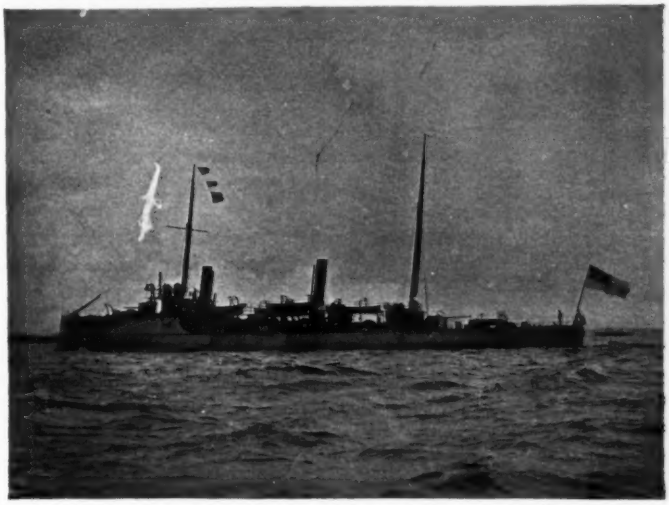
erate provocation, and, when doing so, cannot possibly use their broadside guns at all, as the muzzle of the weapons would dip at each roll and the battery would be flooded through the ports. Nor can they, with much effect, use their heavy barbette guns; for such violent motion must render good shooting impossible, even if the guns themselves be well out of reach of the water. The defect would be diminished by the addition of bilge keels to the ships; but, owing to the great size of the vessels, it is found that such additions would render them incapable of entering any of our dry-docks, except No. 3 at Plymouth; and, as all the craft of this type are unsheathed and uncoppered, frequent docking is, unfortunately, necessary to their continued usefulness. Another defect which most of the new battleships share with most of the new cruisers is that they would possess hardly any bow and stern fire if some accident occurred to prevent the working of the heavy guns of the principal armament. This point has, I venture to think, been much more wisely considered by those who are responsible for the designs of the American coast-line battleships *Oregon*, *Massachusetts*, and *Indiana*, and of all the French battleships of recent types

In the matter of weakness of bow and stern fire the battleships

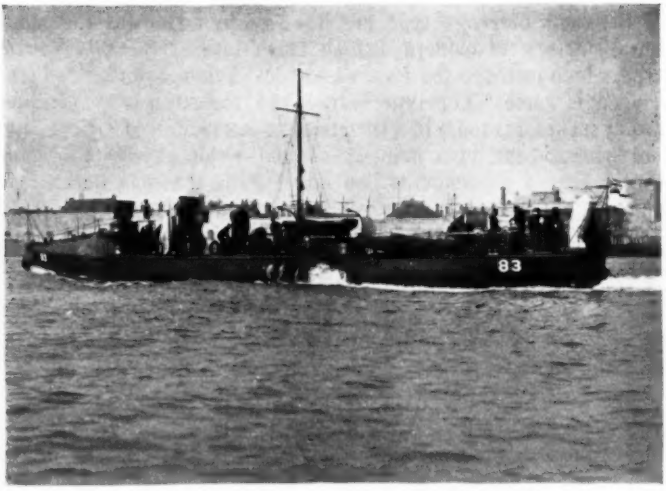
of the *Royal Sovereign* type are, however, by no means the most unsatisfactory of modern British battleships. The *Sans Pareil* type, which included the *Victoria*, lost last summer in the Mediterranean, is worse. This type carries two monstrously heavy guns (16.25 inches, 111 tons) in a turret on the low forward deck, but cannot bring to bear on a point ahead of the ship any other weapon bigger than a 6-pounder. The heavy guns that can be trained right astern are confined to one 10-inch and two 6-inch. This feebleness will best be realized if I compare the bow and stern fire of the type with the bow and stern fire of the United States ships of the *Oregon* type, which are of less displacement:

	H. M. S. "SANS PAREIL."			U. S. S. "OREGON."	
	Guns.	Total Muzzle Energy. Ft. tons.		Guns.	Total Muzzle Energy. Ft. tons.
Bow.	2 .. 16.25 in. 111 ton...	108,780	2. ..12 in.....		51,970
			4.... 8 in.....		29,992
			2... 6 in.....		5.980
	2	108,780	8		87.942
Stern.	1... 10 in. 29 ton.....	14,430	2 .. 12 in..		51,970
	2.... 6 in. 5 ton.....	5,330	4.... 8 in.....		.29,992
			2 ... 6 in.....		5.980
	3	19.760	8		87.942

The bow fire of the *Sans Pareil*, though certainly heavier than



THE NEW BRITISH NAVY—TORPEDO-GUNVESSEL "GOSSAMER."



THE NEW BRITISH NAVY—TORPEDO-BOAT OF THE "M" TYPE.

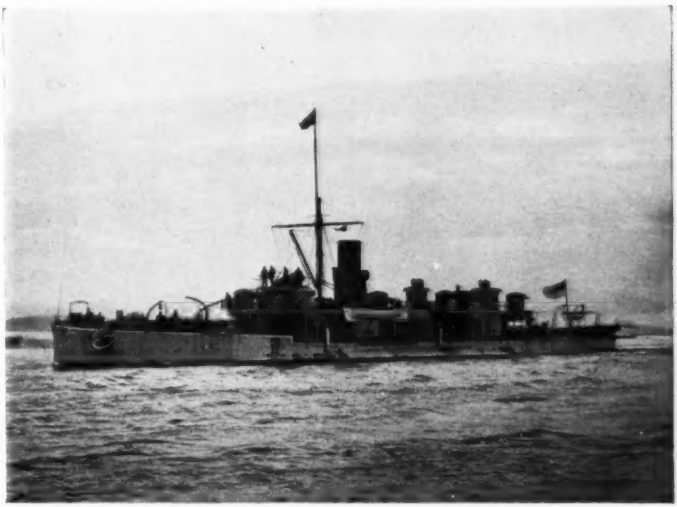
that of the *Oregon*, is delivered by only one-fourth of the number of the *Oregon's* bow guns ; and I do not hesitate to say that if the *Sans Pareil* and *Oregon* had to fight one another bows on, and if the gunners of both ships were equally smart, the British ship—unless, of course, she happened to plant a lucky shot at the commencement of the action—would, say in a quarter of an hour, be unable to get rid of more than about half the energy that would be got rid of by the *Oregon*. As for stern fire, the *Oregon's* would be altogether superior from start to finish ; and, upon the whole, I would be inclined to think that against the *Oregon* the *Sans Pareil* would have but a poor chance.

As befits a power that has naval interests more widely scattered than those of any other nation, Great Britain ought to have given to her modern battleships a relatively large coal carrying capacity. Some of her earlier ironclads have stowage for as much as 1200 tons or even more, but none of the modern ones have provision for upwards of 900 tons ; and I think that this is, if gaged by other standards, an insufficient amount. I give, by way of illustration, some statistics of the quantity of coal carried, per horse-power developed at full speed, by the most modern battleships of the leading countries. The figures following the names represent hundred-weights :

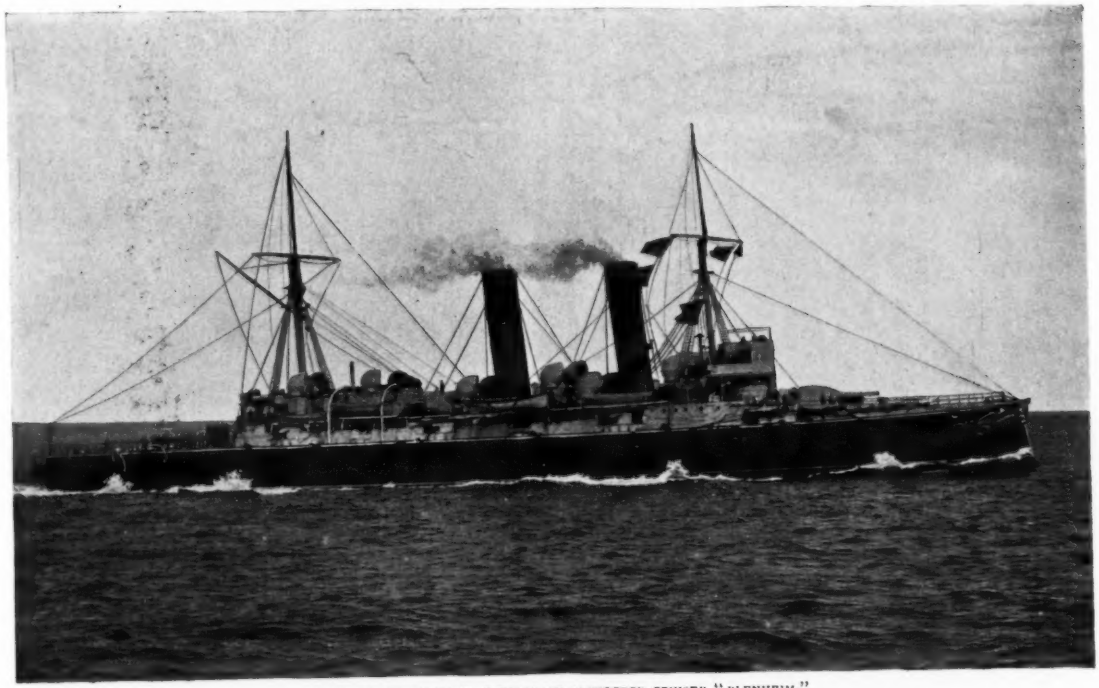
GREAT BRITAIN.		UNITED STATES.		FRANCE.		ITALY.	
Benbow,	1.5	*Maine*,	1.8	*Neptune*,	1.4	*Morosini*,	1.7
Sans Pareil,	1 0	*Oregon*,	.8	*C. Martel*,	1.2	*Sicilia*,	1.2
Royal Sovereign,	1 3			*Masséna*,	1.0	*Sardegna*,	1 0
Renown,	1.3	RUSSIA.		AUSTRIA.		*Am. St. Bon*,	.8
Majestic,	1.3	*Tchesme*,	1.5	*Kr. Pr. Rudolf*,	1.6		
		Tri Sviatitelia,	1.5				
		Alexander II.,	3.0				

Now if the United States finds it necessary to give as much as 1.8 cwt. of coal per horse-power ; if Italy finds it necessary to give 1.7 cwt., and if Russia finds it necessary to give 3 cwt. to a ship,—surely we in England, looking to the extensive nature of the British empire, and the probability that action may be required in comparatively distant waters, ought to give our battleships more than 1.3, or even more than 1.5 cwt., per horse power. The relative smallness of our bunkers may, I fear, handicap us seriously, should we in the near future be plunged into war.

The armored-cruiser classes (B^1 and B^2) of the new British navy have proved very satisfactory in one important respect. They are all excellent steamers, and, in everyday practice, they attain perhaps a greater proportion of their nominal speeds than any other modern vessels of war afloat. But in two other respects they are disappointing. For two reasons they scarcely deserve



THE NEW BRITISH NAVY—RAM "POLYPHEMUS."



THE NEW BRITISH NAVY—FIRST-CLASS PROTECTED CRUISER "BLENHEIM."

the name of armored cruisers. Firstly they have very short belts, and secondly such belts as they have are almost entirely submerged when the vessels have all their coal and stores on board in readiness for sea. In a word, if in war-time one of these vessels left a British home port on a cruise and a few hours after leaving were met by an enemy, for all practical purposes she would not be an armored cruiser at all, but merely a protected one, owing to the fact that all, or nearly all, her external armor would be under water. Some error was, apparently, made in the original calculation of, and provision for, the weights to be carried.

The numerous types of unarmored cruisers, protected chiefly by means of horizontal armored-decks, have, upon the whole, been fairly successful as steamers; but as fighting ships most of them, and especially those of the later varieties, leave much to be desired. Particularly deserving of condemnation in this respect are the numerous vessels of the *Andromache*, *Pique*, and *Fox* (D^3, D^4, D^5) classes. The guns of these, excluding machine-guns, are:

"ANDROMACHE" AND "PIQUE."	"FOX."
2 6 in.	2 6 in.
6 4.7 in.	8 4.7 in.
8 2.24 in. (6-pr.)	8 2.24 in. (6-pr.)
1 1.85 in. (3-pr.)	1 1.85 in. (3-pr.)

From their speed and certain other qualities, as well as from their official designations, it is clear that they are primarily intended (1) to act as scouts for a fleet, and to show their heels to heavy-armored vessels, and (2) to catch and take lightly-armed vessels. In pursuance, that is, of one part of their duties, they are expected to flee and fight stern on, and in that of the other part to chase and fight bows on. Never, as far as arrangement of armament is concerned, were ships worse fitted for either kind of service. Each of these 29 vessels has a single 6 inch gun on the deck forward, and can only bring that and a couple of 6-pounders to bear on any craft of which she may be in chase. She has also a single 6-inch gun on the deck aft, and can only bring that and a couple of 6-pounders to bear on any craft which may be chasing her. For bow- or stern-fire, in fact, all her 4.7-inch guns and half her 6-pounders are perfectly useless. The total bow- (or stern-) fire of these vessels amounts merely, in weight of metal, to 112 pounds, and, in aggregate muzzle energy, to 3636 foot-tons. To show how utterly inadequate this is, I append a statement of the amount of bow fire from guns of 5-inch caliber and upwards, of these and of cruisers in the navies

of other countries, of about equal displacement—viz., between 3400 and 4360 tons :

Cruiser.	No. of guns bearing ahead.	Weight of metal thrown. Lbs.	Muzzle energy developed. Ft. tons.
United States, *Charleston*.	3	450	12,478
Germany, *Irene*	4	305	10,275
France, *Jean Bart*.	3	266	7,113
Great Britain, *Andromache*, etc.....	1	100	3,356

In the British classes which are here described the practice of placing the forward guns on each broadside in sponsons has, for some mysterious reason, been abandoned. Hence comes the remarkable deficiency of bow-fire. But in the larger cruisers of the *Royal Arthur* and *Edgar* classes the old practice has been retained, and those ships, in consequence, have available for right-ahead fire 3 guns, throwing 580 pounds of metal, and developing in the aggregate a muzzle energy of 17,622 foot-tons. Attention is being paid to further improvement of bow-fire in the *Powerful* class (C^5), but the improvement will not go as far as it should. Cruisers of that enormous size, with their 70 feet of beam and their high freeboard, ought to be able to bring to bear right ahead at least 1 9.2-inch, 4 6-inch, and smaller guns. The actual arrangement of the armament is, as I write, still undecided ; but it is determined that, in addition to machine-guns, it shall consist of :

No.	Guns	Weight of Metal. Lbs.	Muzzle energy. Ft. tons.
2	9.2-in. R. B. L.	760	21,820
12	6- in. R. F.	1,200	40,272
18	3- in. R. F.	216	7,092
12	1.85-in. R. F.	36	963
44		2,212	70.147

This is an armament of a very serious character. If the ship were engaged on both sides simultaneously, and if the guns were loaded, trained, elevated, and fired as smartly as similar guns are worked every day by the men of H. M. S. *Excellent* at Portsmouth, the number of aimed shots delivered in a space of one minute by the above guns might be about 300 and the weight of metal about $3\frac{3}{4}$ tons. I do not cite this as an example of what could be done during any considerable number of minutes, but merely to show the nature of the fire which the *Powerful* will be capable of delivering for a more or less brief period. The ship will also carry Maxim automatic machine-guns. She is to have tubulous boilers of the (French) Belleville pattern, but these are being made in

England. The 6-inch guns probably will be in separate armored casemates, as in the battleships of the *Royal Sovereign* type.

The torpedo depôt-ship *Vulcan* began her existence as a failure, and, having had her boilers altered, is continuing it as an experiment. Her original design embodied a number of remarkable errors. There were ports for the hoisting out of mines, which were actually below the water-line when the vessel was loaded for sea; there were hydraulic- or steam-pipes arranged in such close proximity to the hatchways for the hoisting up of torpedoes from the magazines that their rupture, with probably fatal results to the men engaged, would have been inevitable if the hatchways, in their primitive condition, had been used; and the great cranes which are a distinctive feature of the ship were at first so fitted that they were useless for hoisting out some of the second-class torpedo-boats which the *Vulcan* carries. But things have been and are being improved, and if Great Britain should in the future build yet another torpedo depôt-ship she ought, in the light of the experience now gained, to be a nearly perfect type.

The *Polyphemus*, the only craft in the British navy that has been specially built to serve primarily as a ram, has met with much professional approval, but the growing distrust of the practical value of the ram in naval warfare seems to have prevented this type from being either repeated or developed in England.

Of the torpedo-gunvessel, or torpedo-boat catcher types (H^1, H^2, H^3, H^4, and H^5), little that is favorable can be said. The *Rattlesnake* is the best of the series. Most of the others cannot preserve a decent speed in a seaway; and I have over and over again seen the torpedo-boats, which they were intended to catch, easily show them a clean pair of heels. Their future usefulness will probably be confined almost entirely to service as ordinary gunboats; and the duties for which they were designed will, it is hoped, be performed by the new class (N) of fast torpedo-boat destroyers, of which the *Havock* serves as a type. She is really little more than an unusually large and unusually fast sea-going torpedo-boat. Several of her numerous sisters will at their trials do over 27 knots an hour, and, from my own experience on the *Havock*, I incline to think that these craft are better sea-boats than their appearance at first sight suggests.

The new British torpedo-boats are very satisfactory, save perhaps that they are not quite fast enough. I have been in them in all weather, and can speak extremely well of their sea-going quali-

ties. Various French, Russian, German, and Italian boats are faster, but, with the possible exception of a few of the German, I doubt whether any are as good all round.

The slow gunboats (K^1, K^2, and K^3) scarcely deserve inclusion in a catalogue of modern ships of war. They are designed chiefly for what may be called police purposes and for operations against uncivilized peoples, but they are good little vessels of their kind. Of ships which have not yet been begun I forbear to speak in detail. I will only say of them that, with regard to battleships, the tendency continues to run in the direction of more belt-armor, while, with regard to cruisers, it points towards largely increased speed, and towards vastly improved bow- and stern-fire.

Our new navy is large in comparison with that of the United States. So is our still surviving old navy. But our naval activity, which I trust will not only be maintained but will also be increased, is stimulated by considerations very different from those which prompt the United States to endeavor to be strong upon the sea. The United States has to support the dignity of the flag and to defend the integrity of its coasts. England has to do this, but to do much more as well. First we have to preserve communication with outlying parts of the empire all over the world; next we have to secure the free oversea passage of our food supplies; and, finally, we have to be ready to meet European complications, which can scarcely cause America any serious uneasiness. While, therefore, we regard with brotherly satisfaction the development of that American navy of the good quality of which we have had in the now remote past such strong evidences, we trust that the people of the United States will bear in mind that nowadays our naval position is no menace to theirs, but that, on the contrary, it is likely to help theirs. Old quarrels—which were, after all, only family ones—having been long since disposed of, and, I hope, forgotten, we may both still remember that we are of the same blood; that for a long period we had a common history; and that forever there must be between us a nearer and more sympathetic tie than can unite any other two nations.

HOW THE ANCIENTS MOVED HEAVY MASSES.

By W. F. Durfee, M. Am. Soc. M. E.

SECOND PAPER.

IN the preceding paper attention was given to the means adopted by ancient peoples for transporting large masses of material. We now come to the methods employed by them for raising and placing in position building stones and monolithic monuments whose size and position have excited the wonder of mankind since the beginning of history.

The value of the inclined plane as a means of raising heavy masses to considerable heights was early recognized by mankind. The most ignorant savage could not fail to observe that it was much easier to attain the summit of a precipice by means of its inclined flanks than to scale its perpendicular face, and that by inclined and gradually-ascending natural paths he could reach heights which would have been utterly inaccessible by other means. Therefore the inclined plane—the simplest of the elementary mechanisms—was undoubtedly the earliest mechanical expedient used by man for raising large masses. As a preliminary to the building of the Great Pyramid, the engineers of Kufu (Cheops, 3050 B. C.) constructed an inclined plane of masonry for raising the stones from the level of the river to that of the rock platform on which the pyramids are built,—a height, according to the French survey, of 164 feet above the mean level of low water in the Nile. This inclined plane or causeway was over 3000 feet in length and had a width of sixty feet. Its eastern end was contiguous to a canal communicating with the Nile, by which the boats carrying the stones from the quarries could deliver them in readiness to be dragged up this vast ramp—doubtless the first artificial construction of the kind—on sleds, by men or animals, to their destination.

In speaking of the transportation of materials we have already incidentally mentioned the employment of the inclined plane when moving and simultaneously elevating large masses, and have shown that in comparatively recent years it was habitually used to facilitate the building of ships in America and Holland, and in the erection of buildings in China; but inclined planes have also been

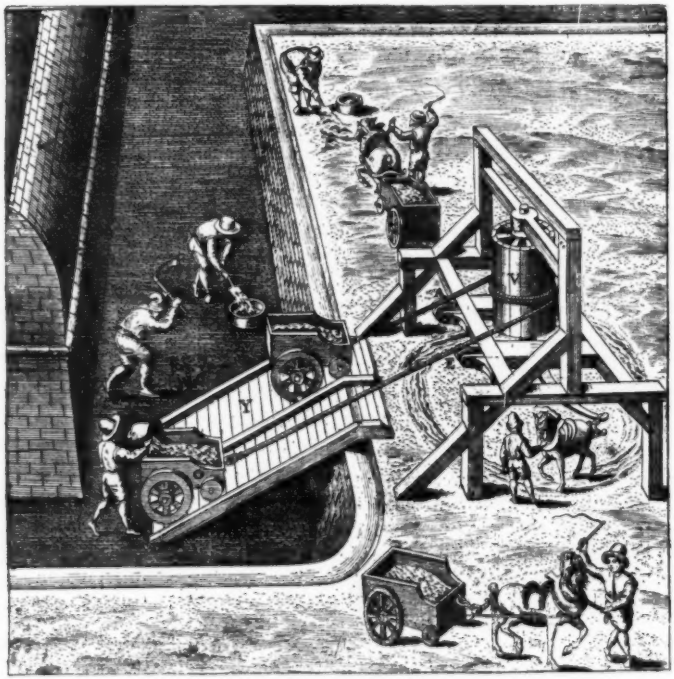


FIG. 1—INCLINED PLANE AND HORSE-WHIM COMBINED.

[From Le diverse et artificiose Machine del Capitano Agostino Ramelli. Parigi, 1588.]

used by many other nations in the erection of buildings. Colonel Wilkes states that, in the construction of the temples in India, "the immense stones were moved end foremost, up an inclined plane of solid earth, of as small an angle with the horizon as circumstances would admit, to the spot which they were to occupy in the wall. Long bamboo poles lashed to the stone at right-angles to its length, at such distance as merely to admit the efforts of rows of laborers between, constitute the chief means of propelling it by main force up the inclined plane, and its ascent is facilitated by means of rollers of small diameter, successively introduced under the stone, and prevented from sinking into the earth by rows of planks placed on each side of the stone, parallel with the line of ascent."

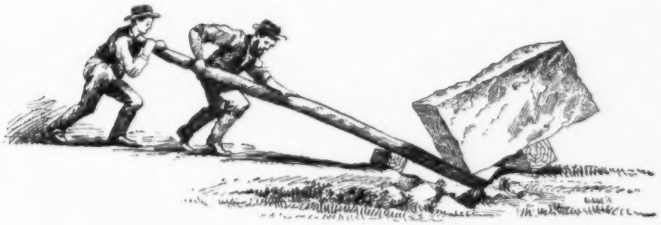


FIG. 2.

The figure on page 794 illustrates the application of the inclined plane in conjunction with the "horse-whim" for raising earth from the ditch of a fortification. Inclined planes have frequently been used in building operations in America. There is a well-authenticated tradition that all of the stones used in constructing one of the earliest cotton-mills in Massachusetts were dragged by oxen on "stone-boats" (the survival of the Egyptian sled) up

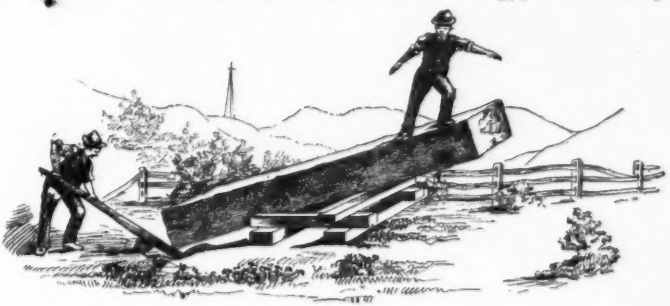


FIG. 3.

inclined planes made of planks and timber, even to the uppermost "stage" of the scaffolding. The inclined plane as a mechanical expedient for facilitating the raising of heavy masses is in daily use the world over in the form of "skids," and it is quite as impossible to number the years of its hoary antiquity as to fix with precision the exact date of the first concert of the morning stars.

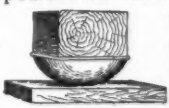


FIG. 4.

A method of raising and turning large stones in constant use in modern "quarries" and "stone-yards," which has been handed down to us from the remotest period, is illustrated by Figures 2, 3, and 4. In Figure 2 a massive stone is being raised by alternately

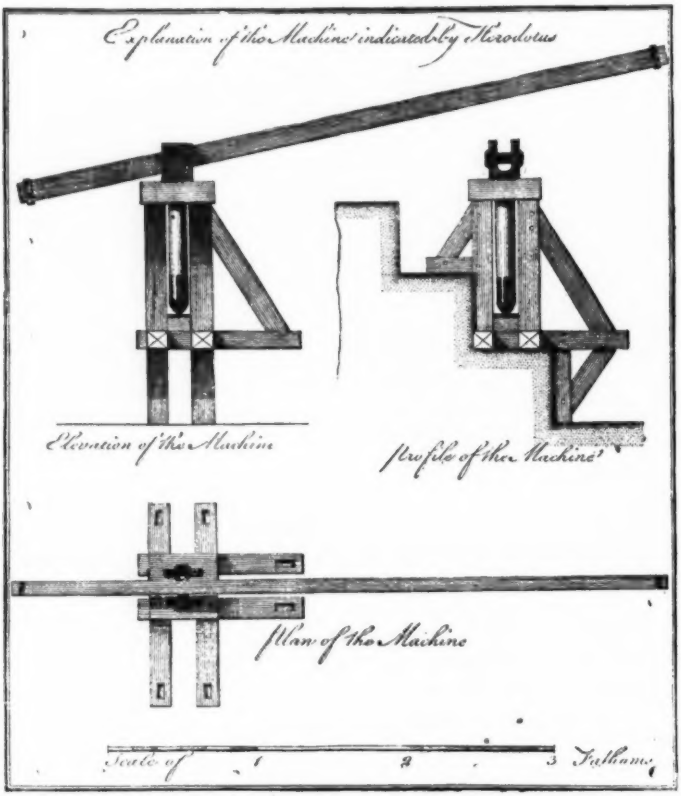

Explanation of the Machine indicated by Herodotus
Elevation of the Machine
Profile of the Machine
Plan of the Machine
Scale of 1 2 3 Fathoms

FIG. 5—DEVICE PROBABLY EMPLOYED ON THE GREAT PYRAMID.

tilting it and placing blocks of timber beneath on each side of its middle. This method, of course, is not suited to raising such stones through a great height, but for "getting them up" a few feet without moving them horizontally no method, in the absence of machinery, is simpler or easier, as the stone is made in a great degree to "lift itself" (to use a workman's phrase) and very little manual labor is required. Figure 3 represents a very old and still very common method of turning over a stone: a block of wood is placed so that when the stone is turned upon the block it will nearly balance, and very little effort will be required in "levelling

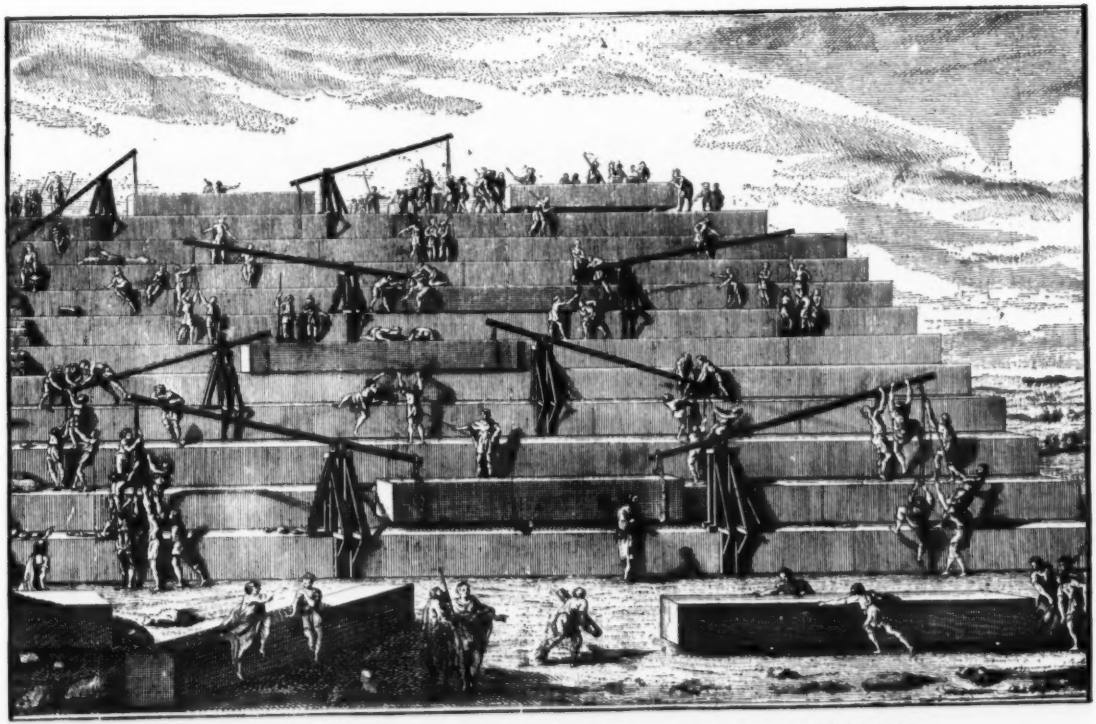


FIG. 6—APPLICATION OF THE DEVICE INDICATED BY HERODOTUS, ILLUSTRATED ON THE OPPOSITE PAGE.

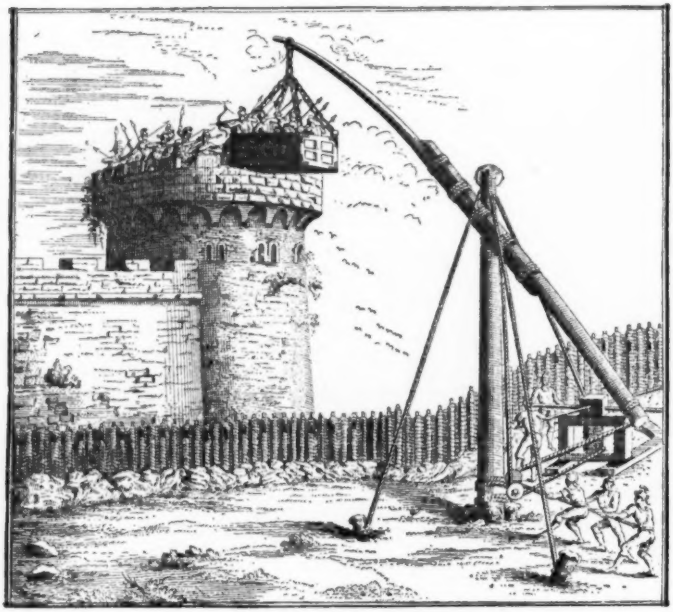


FIG. 7—USE OF THE CRANE IN ATTACKING A TOWER.

it up." In case it is desired to turn a stone "end for end," another ancient idea is employed: the stone is rolled upon a block of timber having a rough-hewn projection formed upon the middle of its lower side (as in Figure 4), which acts as a pivot on which the stone can readily be turned horizontally.

The means used by the builders of the Great Pyramid for placing its stones in position are not certainly known, but it is extremely probable that the methods illustrated by Figures 2, 3, and 4 were employed, for Herodotus states* that, "after laying the stones for the base, they raised the remaining stones to their places by means of machines formed of short wooden planks. The first machine raised them from the ground to the top of the first step. On this there was another machine which received the stone upon its arrival and conveyed it to the second step, whence a third machine advanced it still higher. Either they had as many machines as there were steps in the pyramid, or possibly they had

*Rawlinson's Herodotus, Vol. II, p. 203.

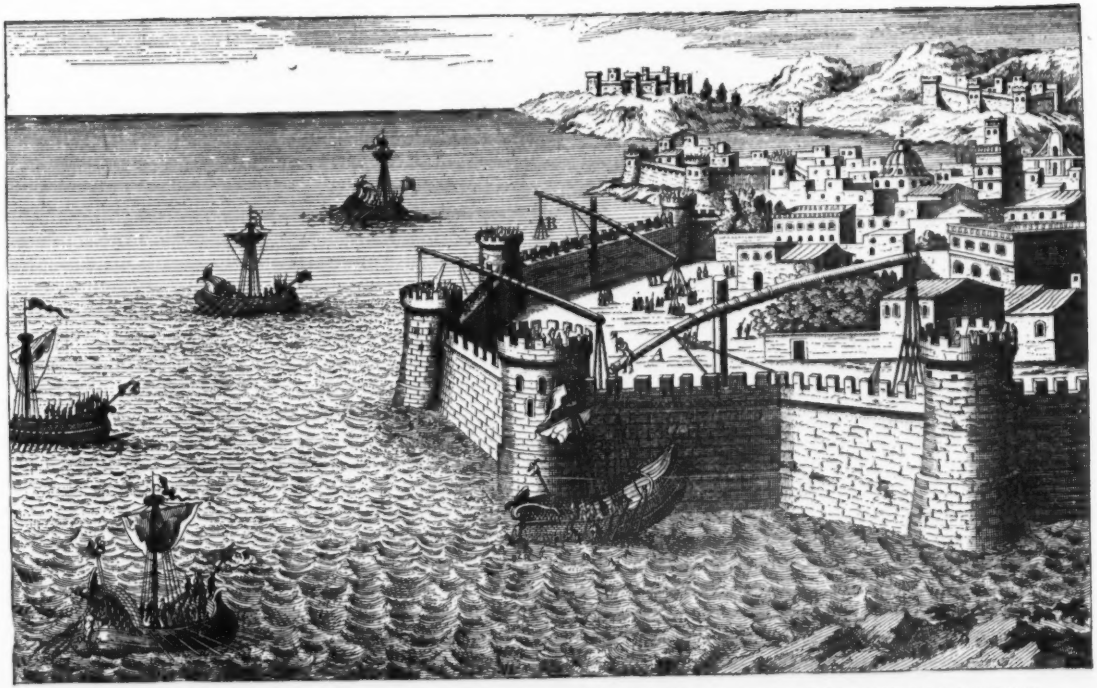


FIG. 9—METHOD DESCRIBED AS HAVING BEEN USED BY ARCHIMEDES AT THE SIEGE OF SYRACUSE FOR DESTROYING THE VESSELS OF MARCELLUS.

but a single machine, which, being bodily moved, was transferred from tier to tier as the stone rose; both accounts are given, and therefore I mention both."

The President de Goguet* makes a suggestion of a possible method of carrying into practice the description of Herodotus. Goguet's scheme is illustrated by Figures 5 and 6, which make it so plain that no detailed description is required. The lever, having a compound tilting and swinging motion, was doubtless already an old idea in Egypt, as it has been in practical use from the earliest times in every "shadüf" † (Figure 11) that creaks and swings on the banks of the Nile from its delta to Ethiopia. The shadüf was used for raising water by many other ancient nations; Layard found it figured in bas-reliefs in the ruins of Nineveh, and it has been in common use in Persia and other parts of Asia from the earliest times. In the shadüf is to be recognized the first attempt at the construction of the simplest of the numerous species of mechanism for raising and placing heavy materials, which we group under the generic term "crane"; and there is no improbability in the supposition that some modification of the shadüf similar to the machine suggested by Goguet was used for raising and placing most of the stones in the Great Pyramid.

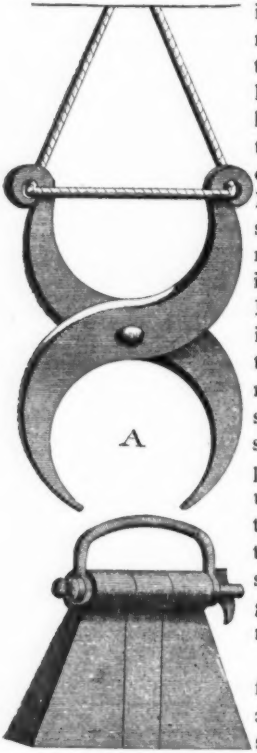


FIG. 9.

As for the largest stones, such as the fifty-six roofing-beams over the "king's chamber,"—which are each over twenty-six feet in length and more than fifty tons weight,—it is very probable that when they were required, an inclined plane of

* The Origin of Laws, Arts, and Sciences, and their Progress among the most Ancient Nations. Translated from the French of the President de Goguet. 3 volumes. Edinburgh, 1761.

† An interesting survival and translation of the idea of the ancient Egyptian shadüf is formed in the "well-sweep" once so common in rural New England, and which operated the "old oaken bucket" that "dripping with coolness arose from the well."

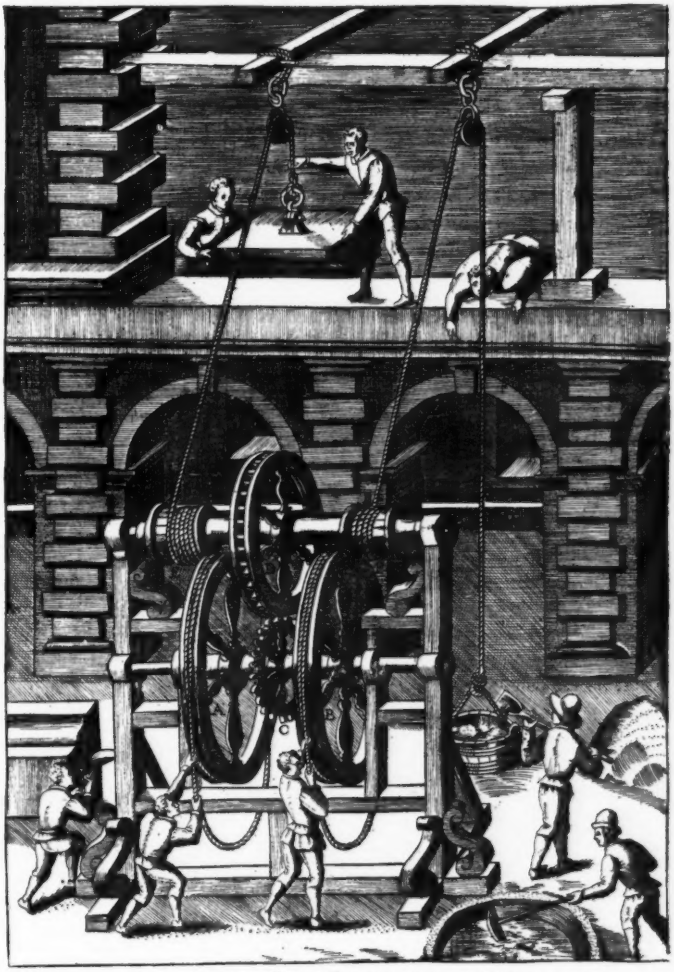


FIG. 10—USE OF THE "LEWIS" IN THE SIXTEENTH CENTURY.

timber was constructed up which they were dragged, for certainly the engineer who thought it necessary to construct the vast masonry inclined plane already referred to, for raising the stone from the boats to the level of the base of the pyramid, would have been

likely to use a similar expedient for raising such heavy masses as these covering beams to their places in the building.

Cranes consisting of a suspended swinging lever were used in ancient military operations, both for attack, as shown in Figure 7, and for defense, as illustrated by Figure 8, which represents the method described as having been used by Archimedes to destroy the vessels of Marcellus at the siege of Syracuse (214–212 B. C.). Long levers suspended by a short chain from an elevated bracket arm were used in Italy as cranes for loading and discharging the cargoes of boats and other vessels as late as A. D. 1676. The means used by the ancients for securing chains and ropes to large masses of stone were various. Wherever possible the well-known method of "taking turns" of the rope or chain around the stone was employed. Quite frequently projecting "lugs" or "bosses" (which were chiseled off after the stone was placed) were left on the stone to prevent the ropes from slipping, or as points for their attachment. For the lighter stones the "tongs" (see *A*, Figure 9)* were used, and there is no doubt of the great antiquity of the "lewis"† (see *B*, Figure 9), while there is reason to believe that

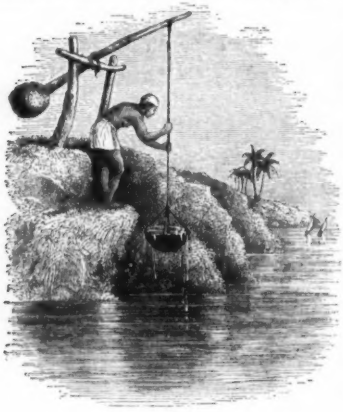


FIG. 11—EGYPTIAN SHADUF.

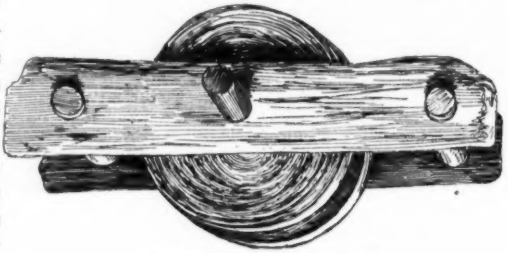


FIG. 12—ANCIENT EGYPTIAN PULLEY.

* From the English edition of The Architecture of Leon Battista Alberti, London, 1755. Alberti was born in Venice about the year 1404 and died at Rome in 1484. He was distinguished as a painter, poet, philosopher, musician, and architect.

† These tools are described by Vitruvius, who lived during the reign of Augustus, and they are not spoken of as recent inventions. In Knight's "American Mechanical Dictionary" the

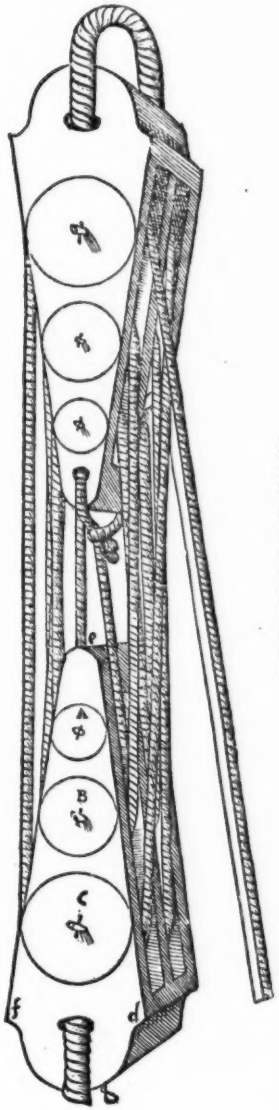


FIG. 13.—ANCIENT PULLEY-BLOCKS.
[From Vitruvius, about 50 B. C.]

it was known to the early Egyptians. Figure 10 illustrates the use of the lewis in the latter part of the sixteenth century. This engraving is also interesting from the evidence it affords of the early use of the rope-wheel in hoisting machinery. It will be noted that in this instance the rope goes one-and-one-half times around the grooved wheel, instead of half round, as is now the usual practice.

"The ancient Egyptians," says Wilkinson," were not ignorant of the pulley, and one has actually been found [see Figure 12] and is now in the museum of Leyden; it is however of uncertain date, and was apparently intended for drawing water from a well. The sides are of *athul* or tonarish wood, the roller of fir; and the rope of *leef*, or fibers of the date-tree, which belonged to it was found at the same time." The pulley was well known to the Assyrians, and is represented on a bas-relief found at Nineveh by

"lewis" is claimed to have received its present form as the result of the improvements of "a Frenchman" who was architect to Louis XIV, and who gave the tool "the name it bears in compliment to his master." In view of the fact that the lewis as now made was used by the ancient Romans for lifting very heavy stones (Alberti states that he has "seen holes [for the lewis] over a foot deep"), it is very probable that this useful implement got its name from the Latin word *levis* (thou liftest), the second person singular of the verb *levo* (I lift). This is made the more probable from the letter *u* having often been written *v* in Latin. If we substitute *u* for *v* in "lewis," we shall have *lewis;* whence our present orthography *lewis*.

Layard. The ancient Greeks and Romans employed the pulley in various ways, and the construction of some of their "pulley-blocks" was quite different from any used at the present time. Figure 13 represents a pair of these "blocks" so plainly that no description is necessary. They also had "blocks" similar to those now in common use, and they were used in connection with sustaining frame-work quite similar to our "gins" and "derricks." Figure 14 illustrates an ancient form of "gin," in which the substitute for gearing is a "wheel and axle." It will be noted that the "blocks" are so "rove" that there are two "falls" to the rope, which are wound on opposite ends of the "axle," and that the "wheel" has a rope wound around it. Whenever it was desired to "hoist" anything to which the lower "block" was "hooked," animals or men were made to pull at this rope, and as it unwound from the "wheel" the two "falls" were wound on the "axle," and thus the weight was raised.

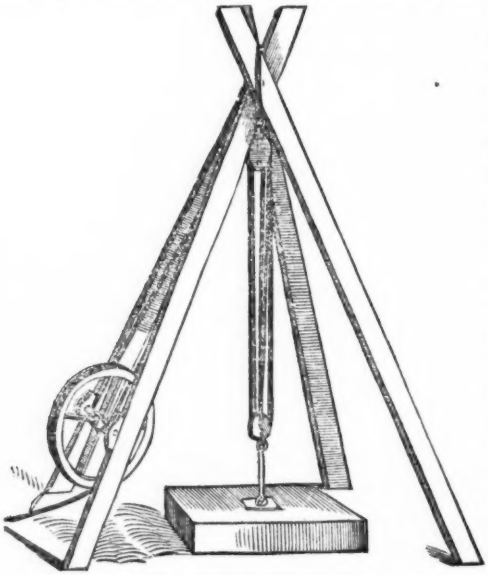


FIG. 14—ROMAN HOISTING GIN.
[From Vitruvius.]

Figure 15 represents a Roman mechanism identical in construction and use with our "capstan" and "shears."

Although the pulley was known and used by the most ancient peoples, still in many cases they preferred to employ means for raising great weights that had in them more of the elements of absolute safety than is found in pulleys and ropes. We are told by Dr. Kennedy, in his description of the construction of the Seringapatam obelisk, that "the elevation was at first accom-

FIG. 15.—ROMAN CAPSTAN AND SHEARS.

plished by men prying with handspikes over timbers arranged parallel with the obelisk, and as it rose earth was solidly rammed beneath it." This method certainly had the advantage of a max-

FIG. 16—SUPPOSED EARLY SUGGESTION FOR A CRANE.
[Reduced from Alberti.]

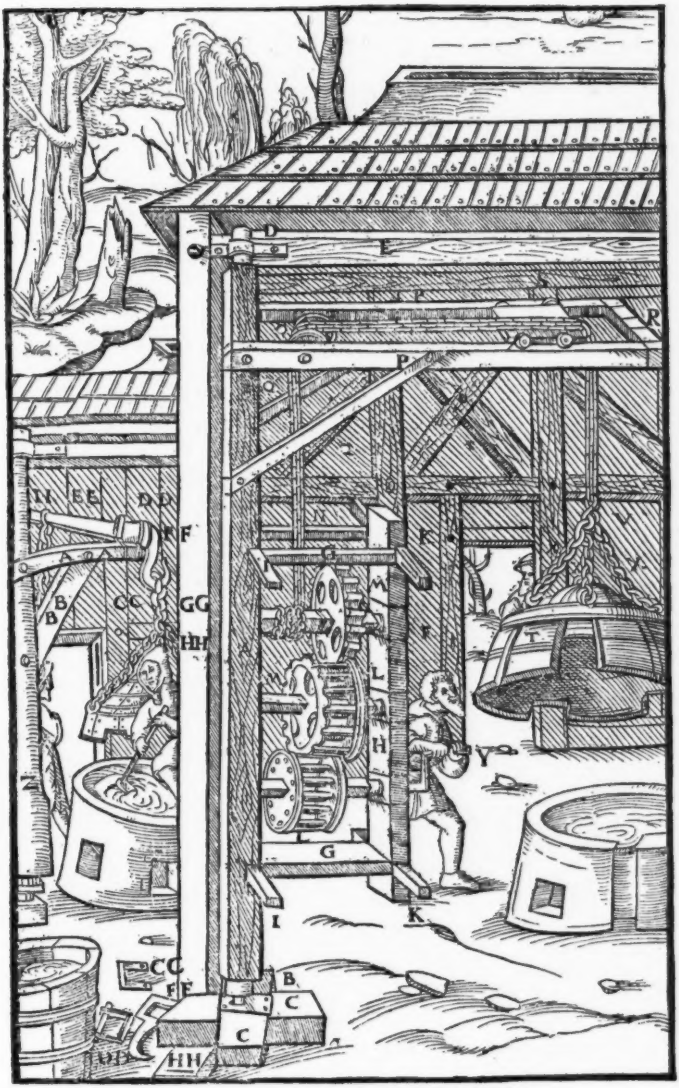


FIG. 17—ANCIENT CRANES FOR SMELTING-WORKS.
[Reduced from Georgii Agricola de re Metallic, Basileæ, 1556.]

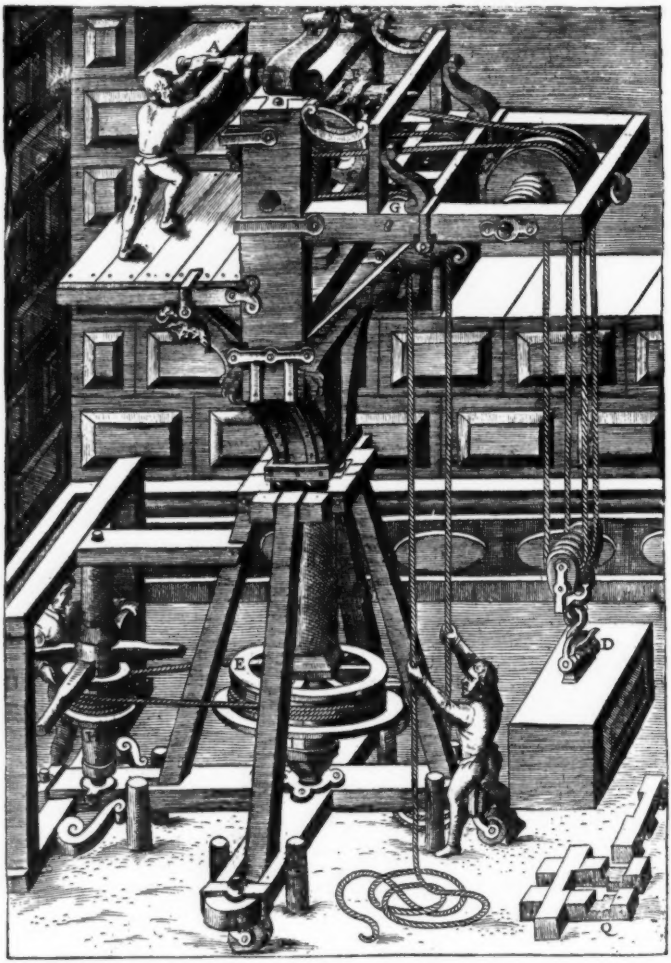


FIG. 18—ANCIENT PORTABLE CRANE FOR SETTING STONE.

imum degree of safety; and, as the operation was conducted exclusively by native workmen by their inherited ways, it is pretty safe to assume that by similar methods all such masses had been raised in India from the earliest times.

It is very probable that the Egyptian method of raising an obelisk was not as safe as the Hindoo plan, for Pliny states that "Rameses (1250 B. C.) made one [obelisk] ninety-nine feet in height on which he employed 20,000 men; and, fearing that the engineer would not take sufficient care to proportion the power of the machinery to the weight he had to raise, he ordered his own son to be bound to the apex, more effectually to guarantee the safety of the monument."*

The first suggestion of a "crane" having a vertical post and horizontal arm was doubtless furnished by the trunk and projecting limb of a tree. The engraving, Figure 16, illustrates in a very spirited and fanciful manner this idea. Figure 17 exhibits two species of crane. The larger is pervaded by a suggestion of multiple gearing from "chain barrel" (or shaft) to the hand crank shaft, and there is also a manifestation of an intention of suggesting a traveling carriage or "trolley" on the arm of the crane, but there is no means evident for either moving or holding this trolley. The second type of crane, shown on the left of that just described, has especial interest, inasmuch as it is undoubtedly a survival of the old Egyptian shadüf, and the early suspended-lever cranes. In this case the operating lever is not pivoted for horizontal movement at its fulcrum, but this movement is effected by swinging the whole crane, the extremity of whose arm carries the fulcrum of the operating lever, which is actuated by a chain dependent from its long arm. For small movements and frequent lifts this very simple idea is well worthy of application at the present day. This engraving, like most illustrations of mechanism in old technical works, must be regarded rather as a rough sketch of the ideas than as a record of the actual proportions of practice.

In Figure 18† we have a representation of a very peculiar and elaborate crane. It will be noted that the crane is made portable

* This story suggests the method proposed by *Punch* for preventing railway collisions: "Strap the managing director on the front of the locomotive."

† In this device [from Ramelli 1588] the hoisting is accomplished by turning the hand crank A, which operates the "worm" B, and its wheel C, on the axis of which is wound a pair of "falls," the free extremities of which pass over guide pulleys F. C. and are kept "taut" by a man on the ground. The other ends of the hoisting rope, after passing over the grooved wheel G, go under the pulleys in the "block" hooked to the "lewis" D, and then ascending are fastened to the axle of the wheel P, which is turned by the adhesion of the rope in its grooves. In hoisting, the rope is "taken up" in two ways: (1) by winding its free ends upon the axle of the worm wheel C, and (2) by winding its other end on the axle of the grooved wheel P. The turning of this crane is accomplished by means of the arms in the vertical shaft H, and its wrapping-rope connection with the wheel E.

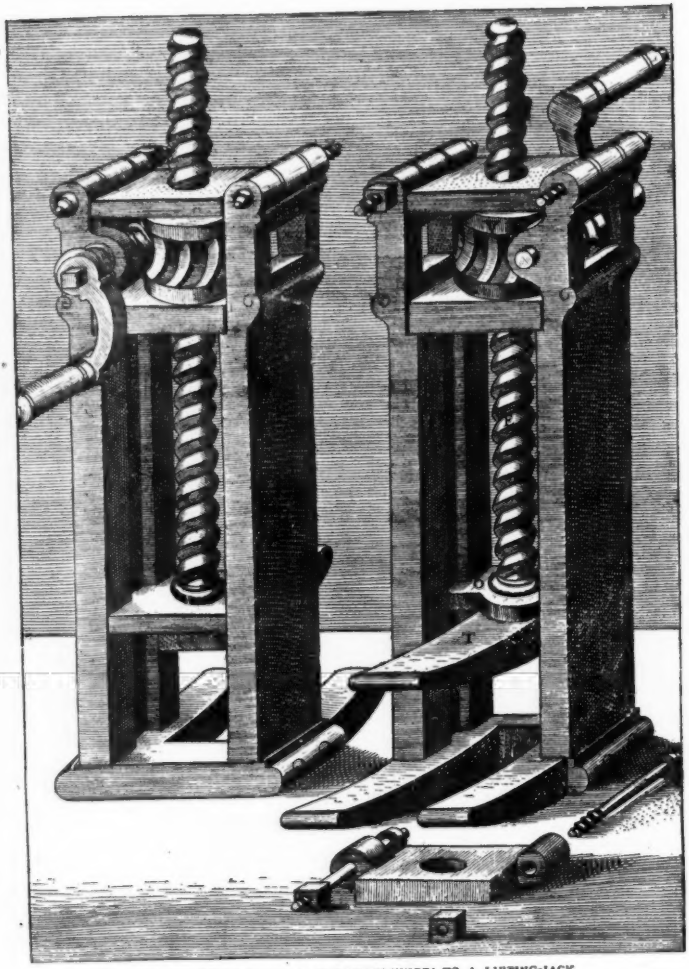


FIG. 19—APPLICATION OF THE WORM-WHEEL TO A LIFTING-JACK.

[From Ramelli.]

by being mounted on "casters" having broad-faced wheels. This engraving is especially interesting as illustrating the antiquity of the employment of the "worm-wheel" in the construction of cranes.

Figure 19 shows the application of the worm-wheel to a "lifting-jack," the wheel rotating about and forming the nut of the lifting-screw. Such "jacks" were designed for lifting the gates of fortified places off their hinges, and also for lifting or turning any heavy mass of material. This mechanical combination has been frequently employed, and has taken a variety of forms. Bessoni (1578) illustrates a press in which three screws, operated by as many worm-wheels, are used. The ordinary "jack-screw" was well known in the sixteenth century, as was also the "double-ended jack-screw," with right- and left-hand screws.

Much of curious interest might be added in continuation of this subject to more recent times, but the middle of the sixteenth century is probably quite modern enough for the expressed purposes of this paper, and therefore I will conclude my cross-examination of History with the usual words of dismissal to a witness: "That is all."

A PLEA FOR SERIES ELECTRIC TRACTION.

By Nelson W. Perry, E. M.

DURING the few years prior to 1879, when the hopes of utilizing the electric current for lighting purposes were high but not yet practically realized, electricians were perhaps about equally divided as regarded methods of distribution. The chief apostles of the two schools were Charles F. Brush and Thomas A. Edison. The former advocated the plan of distributing by unvarying current and the latter by unvarying potential. The former had met with considerable success with the arc lamp some time before the incandescent lamp became known to the public, and, so far as the operation of arc lamps was concerned, his success was as complete as was that of Edison later with the incandescent lamp. While Brush was working with large units intended to be distributed over large areas, Edison was working with smaller units intended for a more limited distribution, and each solved his own problem so satisfactorily that neither method has yet been supplanted in its own territory to any considerable extent by the other, although a borderland between the two territories has been occupied with varying degrees of success by both.

Brush employed a current of constant value and arranged his lamps in series with each other and the source of energy, so that the current passed through each in succession before returning to the generator, the increase of energy required by the multiplication of lamps being supplied by a corresponding increase in pressure at the generating station. This method had at least one recommendation: it admitted of a precise determination of the most economical size of conductors, which held the same relation towards economy so long as the cost of copper and steam-power remained the same, whether there were two lamps burning or fifty, or whether the line were one mile long or thirty. Another recommendation, scarcely less important in the light of subsequent events, was that it permitted the extension of circuits at all times on the lines already laid down without disadvantage to or modification of those portions already constructed. It labored at first under this great disadvantage, however, that since in his system every lamp formed an integral part of the circuit the failure of any disabled all, and the minor irregularities of operation were

cumulative. The solution of this difficulty was found in the cut-out or by-path provided in each lamp, through which the current was automatically shunted in case of failure of the carbons to feed. In this way the integrity of the circuit was maintained independently of the operation of the lamp, and the system has grown until now there is, theoretically, no limit to the number of lamps that can be placed on a circuit, each working independently of all the rest as though it were on an independent circuit. As a matter of fact the Brush company have recently constructed a machine intended to supply 125 2000-candle-power lights from one circuit, and there are many circuits in nightly use upwards of twenty miles in length. The series system, however, is not adapted to the distribution of small currents such as are employed in incandescent lamps. While it has not been approached in its adaptation to the arc lamp, it has made little progress, and that little it has lost, in the incandescent field.

Edison, on the other hand, followed the method of gas- and water- distribution common in our cities and elsewhere, wherein a constant head or pressure is maintained and the increased demand for energy is supplied by an increase in the flow under the unvarying head. By this method the capacity of the mains must be gaged by the sum of the individual demands; in planning an installation provision must be made for the future, and when that provision is exhausted additional mains must be laid to meet the increased demands. This method had the recommendation of greater flexibility, permitting the supply of all-sized individual demands from the same mains with practically independent circuits for each individual translating device. It had the disadvantage, however, of requiring much larger investments in copper, which increased under some circumstances as the square of the demand in current, and shared with our methods of gas-distribution the faults of loss of pressure as the distances increased, especially in cases where the drain upon the mains was large near the source of energy. For this reason the areas that could be supplied from centers of generation were exceedingly limited, though the method was sufficient for the early requirements. As the areas to be covered increased, the ingenious device was resorted to of dividing them up into smaller areas, whose centers were supplied by feeders and mains at the proper potential at their terminals for use throughout the local areas, and thus, and by means of the three-wire system which permitted the distribution of current at double the po-

tential at which it was to be used, the areas that could be economically supplied with current for the incandescent lamp have become comparable to those already covered by water and gas.

But with the advent of the electric railroad new problems were introduced. It was not so much areas as distances that now must be covered, and with the extension of these lines to the suburbs and the growing demand for interurban electric lines these problems become more and more urgent of solution in a different and more effective manner than hitherto.

Brush stopped with his discovery of the automatic cut-out for stationary translating devices, and without an equivalent for the moving car the constant current system lacked sufficient flexibility. On the other hand, with the constant potential method it was only necessary to double or treble the potential to give equally economical distribution to double and treble the distance. Five hundred volts (about five times that upon which incandescent lamps can be used) was decided upon as within the limits of safety, and has become the standard street railway pressure throughout the country. By this means, with the assistance of feeders, even suburban requirements up to eleven or twelve miles (in one extreme instance) have been supplied, but now come the further requirements of interurban lines, which can only be met by this system by a duplication or multiplication of generating stations, with all that is implied thereby. In these longer distances, the constant potential method, if it has not already done so, is certainly beginning to trench upon a domain which does not belong to it, as we shall endeavor to show.

The problem of distributing current to moving cars by the constant potential or multiple-arc system is quite different from that of distributing current by the same method to stationary translating devices, in that the position of the load is constantly changing. The cars at times may be all bunched at the further end of the line, and the feeder provision must be sufficient to meet this contingency. If sufficient for this, it involves an investment in copper so much in excess of the mean requirements as to be a heavy burden on the interest charges. Such a heavy burden is this, in fact, that, when the distances exceed eight or ten miles, it is usually deemed more expedient to erect a second station, with all that that implies, than to make use of sufficient copper to overcome the drop that would otherwise result.

It will be evident that in calculating the copper for an install-

ation of this kind, having a constantly varying and shifting load, the best we can do is to proportion it to certain ideal requirements, which may in practice be met only once or twice in the day's run. For all other conditions the amount of copper employed will not be that which will meet the requirements of maximum economy.

In the multiple-arc system it is dangerous to reverse the direction of motion of the motor while the car is rapidly moving, and hence advantage cannot be taken of electrical braking except in cases of emergency. The moving car is always checked by mechanical means, and in descending a grade its energy of position is entirely frittered away in heat on the brake shoe and wheel-tire.

The single trolley is all but universally used, thus making the track and earth a part of the circuit. This introduces an element of uncertainty in the circuit which can never be provided for adequately by the overhead system of feeders and trolley wire, and one which has caused no end of annoyance. When the ground is soaked in water, the resistance of this return is almost negligible, but when it is dry and parched, or when the track is covered with dry dust or dry snow, it may increase to almost any extent. To obviate these difficulties some companies have actually spent more money in the ground in the attempt to give a uniformly good return to the current than they have spent in their feeders and trolley wire overhead, and yet have failed to obtain an entirely satisfactory result.

Since the electric car has become almost universal in our larger cities a new and equally serious objection to the ground return has developed, in the corrosion of the gas- and water-pipes and metallic sheathing of cables buried in the ground, due to the electrolysis caused by the large currents. This has been especially noticeable in Boston, Cambridge, and Brooklyn, and no adequate remedy has as yet been devised, nor does there seem at present to be any remedy other than the radical one of abandoning the earth entirely as a return and resorting to the double-trolley system. The question of damages for the destruction of water and other pipes by the return currents from electric railways has not yet come up before the courts, but it would certainly seem that the trolley companies should be held responsible in equity if not in law. It behooves us, therefore, to look about us for the means of abating that which is not only a nuisance to ourselves, speaking as street-railway men, but an injury to our neighbor, and it is for the pur-

pose of calling attention to a system which appears to meet all the requirements that this paper has been undertaken.

Brush solved the problem of supplying arc lamps arranged in series on a constant current circuit. He did not go into the street-railway problem on the series method, but his successor, Professor Sidney Howe Short, made a most determined effort towards its solution and actually constructed and operated for a time two small roads on constant current circuits. While his plan proved a failure as a practical system, the results obtained were exceedingly instructive, and demonstrated that, if the series system could be made as flexible as the multiple-arc, it would possess many features of economy, both in construction and in operation, to recommend it far above the latter for traction distribution.

In regard to the series system the following advantages have, I believe, been fully proved and are admitted by all :

I. The installation of the power-station is by far simpler and less expensive than that of a station on the multiple-arc plan.

II. Where high potentials are used, as is necessary in long transmissions, both the dynamos and motors are smaller and cheaper to build than those of the same capacity suitable for constant potential circuits.

III. The amount of copper required for transmissions of equal amounts of power to equal distances is considerably less in the series system, and its weight, having been once determined to best meet the question of economy, continues to meet that question equally well, whether there be one car or many on the line and whether the line be one mile in length or thirty. In fact, since the current remains the same, the question to be solved always is merely what size of wire will, all things considered, most economically carry that current, and this will be determined and hold good irrespective of the number of cars, the length of the line, or the position of the cars on the line. In the multiple-arc system (that now in universal use) the same economy could be obtained only by varying the copper with the constantly-changing position and demand of the cars, which is, of course, an impossibility. In the series system it is obtained by simply varying the electromotive force of the circuit to meet the ever-changing conditions, and this is automatically attended to by the dynamo itself.

IV. It is in many respects safer, for, while high potentials are used in the series system, they are confined to the terminals of the dynamos in the power-station, and the potentials at the car-

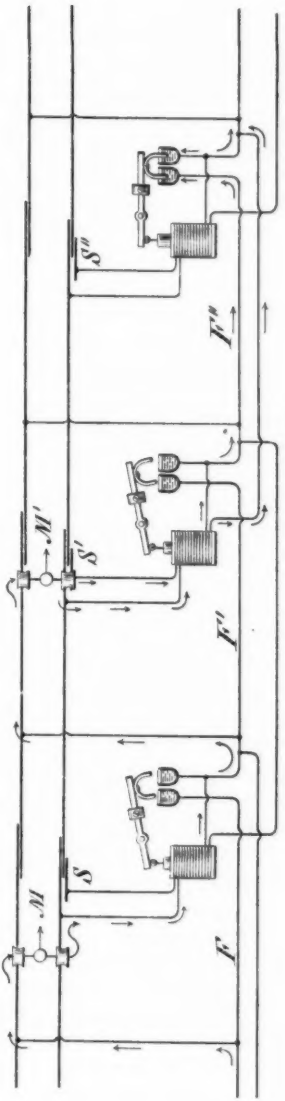


DIAGRAM NO. 1—FEEDER SERIES SYSTEM.

terminals are only proportional to the work which each car is doing at the time, while in the multiple-arc system the high potentials extend to the terminals of every motor on the line, irrespective of whether it is doing much work or little.

The other advantages will be mentioned at the proper place in the description of the method which follows.

In a system which has been devised recently the main features are that a system of feeders is employed as in the multiple-arc system, which, instead of feeding amperes into the trolley wires as in the latter, feeds in volts or electromotive force. This may seem to be a rather strange statement to make in regard to a series system, but it will be better understood by reference to diagram No. 1. *F F' F''* is the main circuit or feeder wire, normally electrically continuous and independent of the trolley wires above. It is, however, divided into sections, each of which is terminated by a mercury cup into which take the copper forks by which these sections are normally connected electrically. The two trolley wires—for this is a double-trolley system—are also divided into similar sections or blocks, the adjacent ends of both wires of adjoining blocks being lapped, but insulated from each other, and the laps are staggered as shown. The further trol-

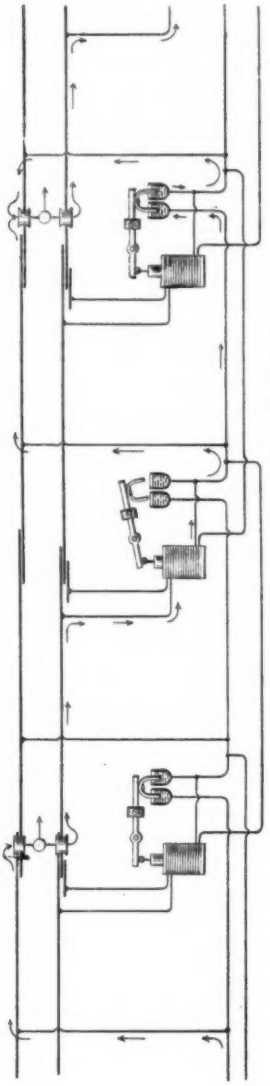


DIAGRAM NO. 2.—FEEDER SERIES SYSTEM—BLOCK TRANSITION.

ley wire of the block is directly connected with one section of the feeder, and the near wire is connected through the coils of an electro-magnet with the succeeding sections of the feeders.

Also parallel to the nearer lap, and anticipating it a little, is a short subsidiary wire $S\,S'\,S''$, which is connected with a second coil of the same magnet wound parallel with the first, and which in its prolongation short circuits the mercury cups of the next succeeding section in advance. The above electro-magnets when excited raise the forks in the corresponding mercury cups, breaking the feeder circuit at that point and forcing the current to take another path. As the trolley-wire sections are normally insulated from each other, no current can ever pass through the magnet unless there be a car on that section. The car-motor therefore forms the alternative path through which the current has to pass when the fork is raised. In diagram No. 1 these features are shown together with cars M, M' on adjacent trolley blocks. The arrows show the paths pursued by the current and also how the two cars are thus arranged in series with one another.

It will be noticed that the supplemental conductors and the laps in the trolley wires are so arranged, relative to each other, that, when a car is traveling in the direction of the main current, the trolley traveling upon the wire connected with the

fork or switch will contact with the supplemental conductor before reaching the lapping portion of the trolley wires, and the companion trolley will reach its lap after the first trolley has reached its lap and before it has passed beyond the supplemental conductor, while, with a car traveling in the opposite direction, the order will be reversed,—the trolley upon the wire *not* connected with the switch first reaching its lap, after which its companion trolley first reaches its lap and afterward the supplemental conductor. In this manner the transition is accomplished in either direction from one section to another, either on the same or another circuit, without spark or interruption of circuit. In fact there is here accomplished for the series railway car what Brush accomplished for the series arc lamp.

As the number of cars operated on one circuit will be limited by the potential it is deemed safe to have at the dynamo terminals, the road is divided up into as many working sections as may be

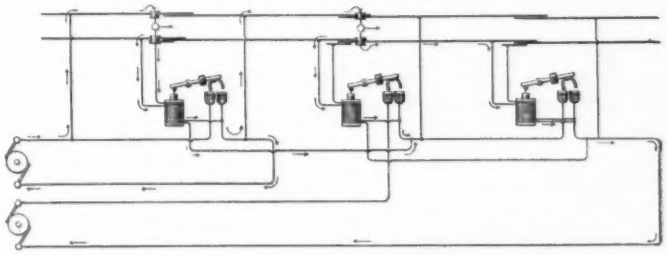


DIAGRAM NO. 3—FEEDER SERIES SYSTEM—FEEDER TRANSITION.

deemed advisable, each of these sections, one of which may consist of many blocks, being operated on a separate circuit. In this way the potentials may be kept within limits.

It is intended that but one car shall occupy a block at a time. Since the block receives current only while occupied by a car, the entrance of the car on the block may set a signal of danger, which is withdrawn on its leaving that block. If, however, notwithstanding the danger signal, a second car should run on to the block, the two would be thrown into multiple with each other and both brought quickly to rest, thus constituting this system a most perfect block system.

The series car is controlled entirely by shifting the position of the brushes. The current being constant, it is perfectly safe to reverse the position of the brushes, even at full speed. By this op-

eration the motor is converted into a dynamo in series with the one in the power station, and contributes electromotive force to the line to the last turn of the wheels. Instead of frittering away in heat the energy due to the acquired motion of the car, as in the multiple-arc system, the car is checked by reversing the brushes, and the energy absorbed by thus checking its motion is thrown on to the line for use elsewhere or to the relief of the steam-engine. In descending a grade, too, the energy stored up in the car as potential in ascending that grade is given out to the line as kinetic energy instead of being thrown away as at present. Since in a round trip there is as much down-grade as up-grade, the track is theoretically reduced to a level, and, since the car is checked as often as it is accelerated, its motion is theoretically reduced to a continuous and uniform one, and the economies resulting from these ideal conditions are by this system and by this system alone theoretically realized. Practically, the economies of operation must be very large, though of course far short of the theoretical.

One of the greatest doubts that I have had in regard to this system concerned the ability of the generator to respond promptly to the enormous sudden changes in potential corresponding to the similar changes in current on multiple-arc roads. This doubt has been entirely removed by the experience in a series-transmission plant at Geneva, which has been in successful operation for nearly two years. Although this plant is driven by water-power, the diagrams show that, while instantaneous fluctuations of 1000 volts were frequent,—on several occasions the variation was between 1400 and 5800 volts,—the regulation was effective and practically instantaneous.

It is believed that this recent improvement renders the series system fully as elastic as the multiple-arc system, and that in view of the difficulties encountered in the latter, the growing tendency to extend electric railroads to greater distances, and especially in view of the recent decision by Judge Greene in the Feeder and Main patent, awarding the sole right to use feeders to the Edison company, aside from its own intrinsic merit, this system will soon attract the attention it deserves of the electrical public.

CITY WATER-SUPPLIES OF THE FUTURE.

By Samuel McElroy.

THE wonderfully rapid and systematic growth of population throughout the United States, and especially in the cities, makes the question of the water-supply of the future one which even now deserves earnest attention. As our municipal centers rapidly accumulate population, and the demands for food, water, light, heat, sewerage, sewage disposal, fire-service, police protection, health protection, burial, transportation, and like services increase, we are gradually forced to consider the experience and practice of the large centers of the old world, ancient and modern. And it may be taken for granted that whatever large centers of population elsewhere have found most beneficial, or imperative, in the accumulated experience of the centuries, may be found worthy of adoption by us, under like conditions of supply and demand. Unfortunately for the best interests of the nation, and of its large cities, we have not as yet fully learned to comprehend the value of disciplined professional experience in public works. Too little attention is paid to the principles of hydraulic construction and operation, established and proved by the centuries.

The United States census for 1890 shows that nineteen of the chief cities in rank—from New York, with 1,515,000, to Louisville, with 161,129, inhabitants—had an average daily supply of 104.6 gallons per person. New York had 79 gallons; Chicago, 140; Buffalo, 186; Detroit, 161; and Brooklyn, 72. The lowest rate was New Orleans, with only 37 gallons daily. The ordinary use and waste of water may be stated roundly at 100 gallons per capita per day. All this must come from the rainfall, the catchment area, the percentage available, and the quantity actually controlled by reservoir and aqueduct delivery.

If we take a rainfall annual mean of 42 inches, and assume 60 per cent. catchment available, each square mile of basin is worth 1,200,000 gallons per day, and will supply 12,000 persons with 100 gallons each. For the purpose of this paper it is not worth while to analyse relative district rains, or catchment proportions, or to discuss the popular delusion that rain-supply is diminishing because changes in basin delivery take place, or the occasional professional demonstration, in the face of experience, that 60 per

cent. cannot be realized with proper outlay. It is sufficient, for the present, to assume that about 10,000 persons can be supplied by one square mile of catchment.

It is also sufficient to assume that as our large cities increase in population their ratio of increase diminishes. The growth in Brooklyn from 1860–70 of 48.58 per cent. declined in 1880–90 to 36.54 per cent. The decline in New York was from 58.5 per cent. in 1850–60 to 19.47 per cent. in 1880–90. In New York State it was from 73.1 per cent. in 1790–1800 to 18 per cent. in 1880–90. The decline in the United States, by decades, from 1850, was 35.-58, 22.63, 30.08, and 24.86 per cent., respectively. If we assume, therefore, an average increase per decade of 25 per cent., in a case where it is best to estimate liberally, the population doubles in thirty years.

Applying these conditions to Brooklyn, that city will have in 1920 a population of about 1,600,000, requiring the entire available yield of 160 square miles catchment. The basin of the 12.39 miles of original aqueduct is 88.64 square miles, and that, with the 7 33 miles extension, will barely furnish the required total. New York, on the same basis, will have in 1920 3,000,000 inhabitants, requiring the full supply of 300 square miles. The entire area of the Croton basin above the old dam is about 339 square miles; the new dam will make this about 350, and the Bronx catchment is 22,—a total of 372 square miles. Boston in 1920 will have about 900,000 population, requiring 90 square miles. To the Cochituate basin of 19.72 square miles it has added the Mystic lake of 26 87 and the Sudbury of 73.73,—a total of 120.32 square miles.

Cities like Philadelphia and Cincinnati, on large rivers, draw from larger catchments, and those like Chicago and Cleveland, on great lakes, have the same advantage.

It is not necessary to extend this analysis of relative supply as to quantity available and demand. Enough has been shown to prove that within the next generation, under present practice, most of our American cities will face a very serious problem.

This problem, at the outset, has to admit an integer in the equation which has not been properly recognized by our hydraulic engineers or city authorities. Whatever may be the available catchment of any supply-basin, this basin is itself accumulating a population and a supply demand which must directly interfere with that of the distant city now appropriating the flow.

In the active and prolonged discussion of the Quaker Bridge

dam on the Croton river one of the objections made was the neglect of proper city jurisdiction in the valley. Of 339 square miles of area the city had lease-control or actual ownership of about 6; and with 361 square miles at the new dam, it would control not more than 16 or 17. The argument was conclusive that the owners of this area had a constitutional right which the courts were bound to protect to the first and full enjoyment of the rainfall, stream flow, domestic, factory, sewerage, agricultural, and other water-rights, on their own property, for their individual and collective use.

Brooklyn, in actual fee, owns a very small area of the catchment—less than one square mile. Its supply differs from the Croton and many other surface-flow catchments in that about one quarter is surface-flow; another comes from outcropping springs near the aqueduct, and about one half from deep tubes of driven wells along the aqueduct. Boston and many other cities depend on surface-flow of their basins.

This brief but explicit examination of a simple question of available supply for the present practice of use brings us face to face with the conclusion that for many of our cities, some time before 1920, the interferences alone will seriously tend to reduce supplies from the basins used. To continue then a daily supply of about 100 gallons per person cannot possibly be kept up as a rule. There are here some valuable lessons in European practice as to economy or control of use.

Rome, about the time of Christ, as a city of luxuries—the public baths being prominent—had built nine costly aqueducts. About eighty years after Christ, for a population of about a million, the supply is estimated to have been 196,000,000 gallons per day. In this supply not only was great care exercised in selecting the sources, but, along the aqueducts, as in the city reservoirs, special provision was made for depuration by aëration, and by bottom blow-offs. There was a marked difference in the use to which these several supplies were applied—some being more potable than others—and in the maintenance of their available heads in the city. The distributing reservoirs were 27.4 to 158.8 feet above the Tiber. For the best supply the Aqua Marcia, collected from mountain springs, was brought sixty miles. About A. D. 60 Rome was taught our lesson of the coming generation, since the local property-owners appropriated the water-supply to their own houses and gardens.

London, at present, draws 55.5 per cent. of its supply from the Thames, 25.2 per cent. from the Lea, and the balance from springs and wells. In July, 1893, it used 199,563,488 gallons, or about 37.1 per person. The mean use in 1890 was 30.93 gallons. It has been estimated that there is available, in its vicinity, in this way, about 425,000,000 gallons per day; the catchment of the Thames is 3086 square miles, and the Medway, to which alternate resort is contemplated, has 481, with a mean annual available flow of about 748,000 gallons per square mile. All the supply is carefully filtered, and there is a constant tendency to improved depuration. As at Rome, the distributing reservoirs differ in level, from 82 to 400 feet above Trinity datum.

At Birmingham, England, the consumption is stated at 15 gallons per person; at Manchester, 24 gallons, and in sixteen European cities the average is 27 gallons.

Liverpool, in 1892, introduced a new supply from an artificial lake in Wales, at an outlay of $10,390,000. The aqueduct is sixty-eight miles long to the Prescot distributing reservoir, the distance from Lake Vrynwy to the Town Hall being seventy-seven miles. The lake basin covers 29 square miles, of which the city has purchased 22.55; in addition, two small basins and reservoirs, of 8.12 square miles are used. This basin has a large rainfall, 49.63 to 118.51 inches, with only 30 at Liverpool. The contemplated draught is 40,000,000 gallons per day, to be maintained by the storage of 12,131 millions. The question of local demand has been respected here, and a flow of 10,000,000 gallons daily must be made to the Severn valley, from the lake, with an addition of 52,000,000 for thirty-two days, between March and October. The present population is 800,000, and the supply in 1874 23.8 gallons per person.

Paris, in 1869, was using 28 gallons daily per person; in 1884, 40 gallons, and in 1887 about 48. The new works of 1887 were to supply 66 gallons. In 1789 the supply was 2½ gallons.

In direct distinction from the large European cities of to-day, with about 30 gallons per person as an ordinary provision, the supply in the chief cities of the United States—not less than 100—invites serious examination. Water is used in our dwellings for drinking, cooking, washing, cleaning, water-closets, and bathing; in our lots and streets for fountains, sprinkling, drinking- and fire-hydrants, horse-troughs, stables, and building; in our office-buildings, shops, and churches for power; on our wharves, for steamboats and shipping; for railways and other like uses.

Brooklyn, in 1891, used, as reported, 58,025,000 gallons per day; of this, domestic purposes took about 48,361,000, and "register" and "meter" accounts, 9,664,000 gallons. If we assume charges as a fair basis of comparison, regulated on meter and other measurements, the use for other than domestic service was about as follows: for factories, 54 per cent.; miscellaneous, 30; bars, 6; stables, 5; steamboats, 2; and building, 3,—this division accounting for 16.65 per cent. of the total. In domestic use, evidently, the personal item is small for drinking, cooking, and laundry; and, distributed over a whole city, the relative use for closets and bathing is small.

Drinking, washing, kitchen, and laundry requirements could well be met with nine gallons per person; whether the comparatively restricted use of closets and baths need double this quantity is a question. For fires the time of use is limited, and the supply comparatively small. In 1890, the daily average was 3.4 fires, amounting—for two hours each, for three engines, at 800 gallons per minute—to 326,400 gallons. At twenty gallons daily for house use, for 850,000 population, the daily amount is 17,000,000 gallons; fires, 350,000; street-sprinkling, etc., 250,000; extras, 9,664,000; total, 27,264,000, or about 32 gallons per person,—an estimate which London experience abundantly justifies.

If we press this analysis a step further we find a waste as wanton as it is costly. In our kitchens the presiding angel, born poor, with the instincts of poverty, when surrounded by luxuries grows fancy-rich on what she can waste. Coal, wood, gas, food, water, clothes, crockery, somehow pay toll as they take wings. If in addition, as is so common a case, the plumbing is defective, even a small leak will waste enormously every day. In hot weather the water is run to cool it and in the cold snaps it is run to warm it.

A correspondent of the Brooklyn *Eagle*, November 28, 1892, calls attention to a saloon and contiguous waste of about one gallon a second; to a leaky hydrant running a constant one-inch stream for years; to another like it; to a flowing car-stable penstock; to a bath-room faucet five years in flow.

The underground wastes are also formidable, as all the sewers prove. Cast-iron water-mains crawl more or less under temperature changes, and the joints frequently show leaks; settlement of bed, heavy trucking, etc., have the same effect; undiscovered flaws leak, and gradually oxidized and tuberculated surfaces leak in time. Any water-purveyor's report, faithfully made, tells the annual story

of serious waste. In department extensions serious increase of waste may follow a change in a carefully-studied system of distribution. In 1892, for Brooklyn, a single change of this kind raised the increased mean supply or waste from about 3,000,000 annually, from 1887 to 1891, to 9,511,649 in 1892.

Evidently, then, the impending strait with which another generation is threatened requires an exercise of common sense in reducing this waste. It would be better to introduce house meters, with some obvious objections, than to continue this waste. And if our waterworks officials will stop the use of meters built like pocket watches, where simpler and more durable ones, registering within 5 or 10 per cent., are just as effective, one serious cost objection would be early removed; but before that careful inspection would remove a number of flagrant losses.

Salt-water supply on or near all tidal fronts would furnish a direct, valuable, and inexhaustible supplement for city use, and for a large number of cities this use will become imperative in time, and should be anticipated. For bathing, water closets, street-sprinkling, sewer-flushing, fire-service, and power it has special advantages, from its chemical constituents, purity, temperature, frost standard, and greater weight.

In 1876, at the request of Commodore Levy, U. S. N., the writer made an argument before a committee of the New York common council, comparing the economy of pumping salt water with the then proposed expenditure of $19,000,000 for the Croton aqueduct extension, in a case where a control of but 200,000,000 gallons per day was estimated as available, and where insurance-men strongly advocated its use for fires.

Of course this involves a special pumping and distribution system, but in the best days of Rome the advantages of distinct systems of reservoirs and mains were recognized for supplies of different potable value. The cost for a city like New York is moderate as compared with gravity outlays. An entire distribution of 600 miles, at present prices, would not exceed $5,000,000. For pumping plant, assuming 60,000,000 gallons per day for a population of 2,000,000, about $1,000,000 would be the cost. The original Croton supply cost $11,453,000, of which, at high prices, the distribution cost $1,877,000; and the new aqueduct, of 300,000,000 gallons capacity it cannot secure, controlling only 115 feet city head, has cost about $25,000,000, which the new dam will make about $35,000,000. As to operating expenses, the item of interest

makes pumping with economical engines much cheaper than gravity, and any desirable head is available. If it is objected that our cast-iron mains will not answer, proper lining and coating will in time improve them, as is now needed for fresh-water use, and as our engineers gradually ascend to the cement practice of the ancients, and dismiss the latest theory that tar-palliated mains are indestructible. If the actual potable domestic supply is brought within ten gallons per person, as analysed, the range of tidal supplement becomes very important.

In our present practice no distinction is made, as in Rome, as to the several uses of the supply. Whether the water is to be imbibed by an invalid or to wash a wagon wheel, equal care or want of care is given to its quality. Under this system a contingency in our suburban catchment-basins, entirely independent of rainfall quantity or interception, arises from its immediate contamination from local influences.

At present, surface water flow, especially in storms, over manured fields, through swamps and other conditions of exposure, is more or less charged with live, dead, or decaying organic matter, as analysis shows in part and the microscope more clearly, and as the universal process of "fermentation" proves. There is also, as population increases, an increased factory and sewage contamination, and to some extent there may be disease-pollution.

While with proper reservoirs storage and depuration, with stream flow and aëration, the underground bacterial action and that of carbonic and other acids exercise a wholesome effect, no student of the future of our water-supplies, recognizing the legitimate first claims of local population in use of its own conditions and privileges, can fail to see that all our supplies must be artificially depurated, as a rule, before distribution. There are various advantages in this, and properly applied it assists essentially in the solution of freeing our available catchment supply from contamination. This applies to surface-flow, to rivers, and other bodies of water, undergoing gradually increasing contamination.

It is now well understood that while reservoir filtration materially improves potable quality, it does not effectually remove organic solutions or disease germs. That portion boiled in cooking, for personal use, is much more improved. Much attention is therefore being given to chemical depuration.

Already many cities of comparatively small supply are doing this; the urgent necessity of effectually restricted waste gains

force in such cases. One sees, on a turbid, yellow, southern river, a tank-house, where dirty, swirling water, passing for a few feet through its chemical and mechanical process, becomes beautifully transparent. If the powerful agents used are not too rapidly absorbed, injuring potable quality, not only is the problem of complete depuration solved, but the contaminated outflow of a populated district can be freely used without apprehension. So a simple use of nature's powerful depurative, iron oxid, as at Antwerp, has proved a rapid and effectual "cure" for organic matter.

The obvious advantage of distinguishing between the potable supply, with its minimum proportion, and that in which chemical depuration, or even filtration, is not necessary, will force itself on engineers in designs for future supplies; and this suggests that the most radical and economical method is to depurate what is actually imbibed, not in the reservoirs, but in our houses. This properly should come under some wise and effectual health regulation, but it is comparatively easy to accomplish that.

In conclusion, this study makes it plain that our large cities cannot much longer ignore the lessons of European experience and practice, and must in time provide better for the future. While it may be Quixotic at present, to reduce water waste 70 gallons, 50 can be gained by proper care. Until recently Brooklyn consumed 54 gallons.

The first duty of an engineer, then, is to put at the service of his clients the best experience of the past, and improve on it if possible, but never ignore it. The worse than useless waste must be prevented, first by rigid inspection, next, as needed, by the meter. With this should come judicious control of the catchment areas. For fire-service, power, and other uses, head is valuable, and for economy, distribution under different heads is important. A direct depurative distinction between what we are to drink or otherwise use must be provided for, and on tidal fronts the eventual use of salt water is to be anticipated.

FLORIDA'S GREAT PHOSPHATE INDUSTRY.

By Alfred Allen, M. A.

IN the early "eighties" the pendulum of Florida's prosperity swung back, in its recovery from negro rule, and an excited crowd whose fixed idea was "oranges" rushed in from the north. Many a man without the capacity to make a living at home was supplied with cash by his too-willing family and sent to this State, though as unfamiliar with its soils as a polar bear might be. It was thought that by sticking an orange-tree anywhere in Florida it would be paying within three years at the rate of a thousand dollars per acre of trees. Nature, in her processes of selection, has a way of her own in fool-killing. Thus, by the "big freeze" of 1886—which, next to "the war," is the chief date in "cracker" chronology—she sent back home from Florida, afoot, a host of poor business men. Without exception these became enemies of the State where they had learned their own want of judgment.

There were some new settlers, however, who had fallen upon the right kind of soil, and who remained and prospered. Then came the newspaper fright over yellow fever, and those who had been caught in the chill shrieked, too. In countries where that disease is ever present it is not so much dreaded as small-pox; but in the United States, on account of its rarity, it becomes a bugaboo and a tempting morsel for the reporters. So it happened that, in the last of the "eighties," Florida was in a bad way. She had received what real-estate men call "a black eye." Taxes were hard to collect and tens of thousands of acres were allowed to go for the dues. When the reports of large profits from the sale of Florida lands to mining companies were first telegraphed around the world, many people knowingly winked, as if to say "we're too old birds for that," and they left the profits for others to reap. Men in the fertilizer business were on the doubtful side and the hardest to convince. Even to day there is doubt on the fair name of the State, due to over-booming, for which reason all the figures here given have been selected from the most trustworthy sources. The accompanying illustrations have been made wholly from photographs, as one wishes to err toward the conservative rather than the opposite pole, if he should happen to err at all.

A VIRGIN OUTCROP OF PHOSPHATE ROCK IN THE PINES.

Now that the phosphate industry has proved remunerative to those who have brought business ability, experience, and sufficient capital to carry cargoes across the sea, the exact figures are interesting, for they convince the world that Florida is not all a coral-reef or barren sand, but the home of an important mining industry. The State has taken place as the producer of an article as staple as coal or iron, and one which is indispensable to modern agriculture.

Let us glance at the statistics of the industry. In 1888 Florida showed but 813 long tons of phosphate to her credit as a mining State. In 1889 the figures jumped to 3780 tons; the "three-year-old" record was 52,381 tons; while in 1891 we saw the bulletin score 181,316½ tons. The year 1892 showed the remarkable production of 354,327 long tons, while that of the past year reached nearer 400,000.

The South Carolina industry began by a shipment of six tons in 1867. Her largest record—586,758 long tons—was shown in 1890. Owing to the inroads made by the competition of Florida river-rock, this dropped off to 548,396 tons in 1892. The year just past will show a still greater decrease, making the figures of the two States nearer even, owing to the disturbances by the cyclone, when the ill wind that bore her so much harm brought better prices and demand for Florida river-rock to fill the loss.

It is too early to calculate fully the effects of such a tide of labor

IN THE TRACK OF THE PHOSPHATES PROSPECTOR THROUGH A FLORIDA FOREST.

PROSPECT TRENCH AND SHAFTS AT ROCK SPRINGS TRACT, FLORIDA.

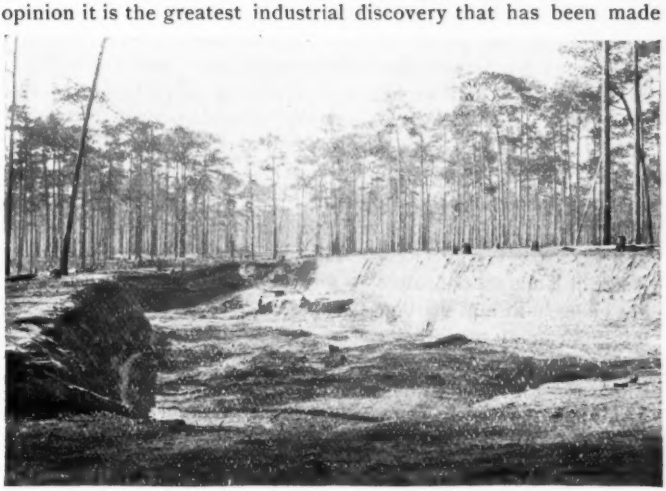
and capital as is necessary to carry on an industry of such magnitude as that of phosphate-mining in Florida, but the importance to the State of this discovery and phenomenal development in her borders is being forcibly impressed upon the minds of the most skeptical. Towns are growing fast at mining centers, about which are scattered the plants whose machinery and outfits have cost more than $3,000,000 and now employ 4000 men. Stores are springing up at cross-roads, with tempting displays of goods to cause the tide of the week's pay-roll to ripple over their counters. Millions of dollars have come into the State to pay for the 200,000 acres of land held by mining companies, and taxes are easier to collect and owners of land easier to find. Already Florida is the paying teller of $5,000,000 yearly which is brought in by the sales of her rock.

Wild lands are considered a more solid investment, for railroads are being built and harbors deepened to accommodate a commerce less ephemeral than that of the yearly tourist crop. There had been invested, up to the end of 1892, $635,950 for spurs and side-tracks on Florida railways to accommodate the phosphate trade, making 149 miles of steel track built for this purpose.

Although railways run to millions, and mining companies are annually spending hundreds of thousands in labor and machinery, we note with pleasure a more general asking of the question among

farmers: "We have the soil and raw phosphates which are enriching the whole of Europe; why not mix the two and have the best crops ourselves?" But a day's journey of a mule from every one of these mines, which extend for 300 miles through the highland portion of Florida, are tens of thousands of acres which could be made a flourishing garden for all early crops. Already this is done near a few mines, and wonderful results are obtained by the use of that soft phosphate which the mines are selling at less than a quarter the price of the same value of phosphoric acid when made into commercial fertilizers. The French, who are the best farmers in the world, use more than 200,000 tons of ground phosphate each year. When Florida farmers learn to take the riches at hand, and accept Dr. Shepard's advice,—"put all the money you can spare into soft phosphate and spread it on your land,"—then will Florida sand rise from the dead, as it were, to a vigorous life.

All our farmers do not yet appreciate the fact that in a commercial fertilizer it is soluble phosphoric acid for which they pay, and not red labels, but this they are gradually finding out. As soon as they are convinced of its truth, they will demand high-grade goods, and Florida is the State where these can be found and furnished. Then will be confirmed the words of Professor Sharples, in the Boston *Herald*, in speaking of Florida phosphates: "In my opinion it is the greatest industrial discovery that has been made



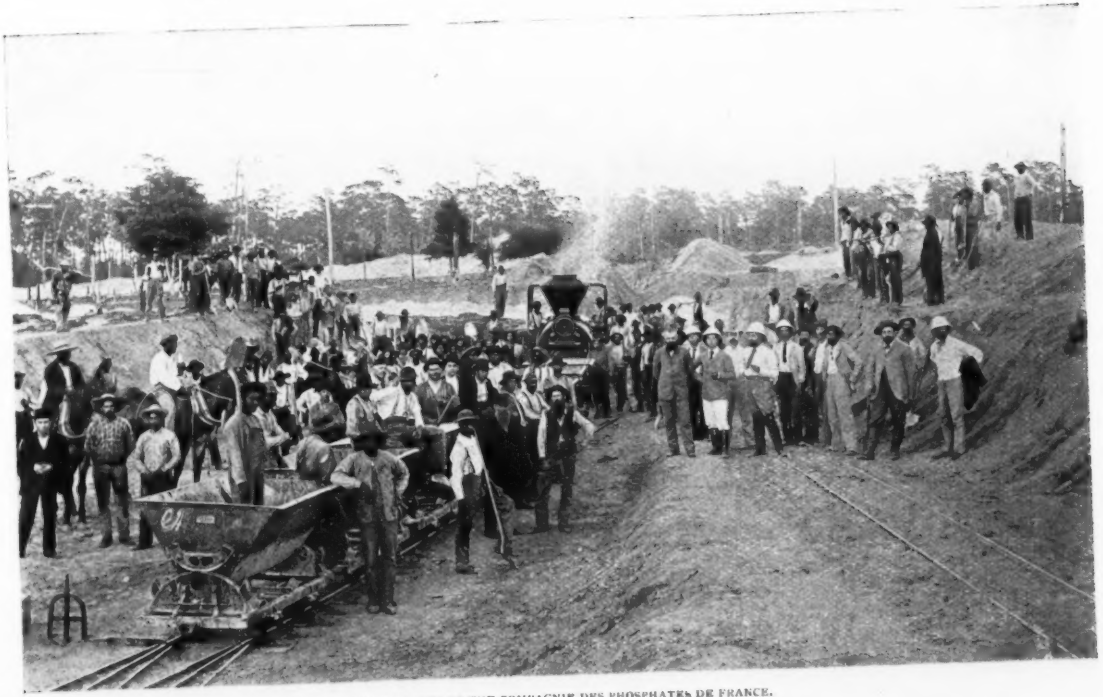
SPRATT TRACT—OVERBURDEN REMOVED, READY FOR MINING.

80-PER-CENT. MARION PHOSPHATE ROCK BEING SUN-DRIED, AND SCREENING FINE GRAVEL TO KILN FOR BURNING.

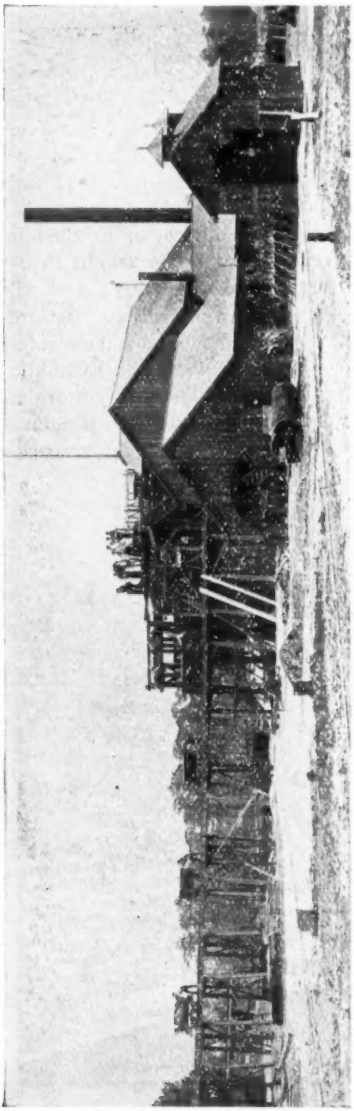
for many years, as well in the matter of its vast extent as in that of its high grade of richness."

It is one of the greatest phenomena of this land of the free that our agricultural class, who are convinced that they can decide the weightiest questions of silver, tariff, or international policy, do not seem to know, though purchasing 1,500,000 tons of fertilizers yearly, that what they should buy and *do* pay for is phosphoric acid *available* as plant-food. The European grower knows this full well and is protected by his government, which makes the manufacturer of superphosphates responsible if the goods are not equal to the guarantee. It also makes the manufacturer liable for the expenses of the analysis, to show whether or not the goods are up to the label. The average commercial fertilizer in the United States has but 8 to 10 per cent. available plant-food of this kind, and when it runs over the manufacturer fills the bag with sand, to keep down the grade, as there is less money in it if raised. Abroad the educated farmer gets 17 to 18 per cent. of immediately available phosphoric acid in his fertilizer, and no sand, at the maker's risk. To make this high grade of superphosphates a phosphate holding, at the minimum, 75 per cent. of phosphate of lime is essential, and Florida produces this grade.

In the last year Florida sent abroad more than 200,000 tons of this rock to enrich the soils of Europe, which used nearly 4,000,000



MINING FORCE OF THE COMPAGNIE DES PHOSPHATES DE FRANCE.



PLANT OF THE COMPAGNIE DES PHOSPHATES DE FRANCE.

tons of commercial fertilizers. That golden time must come when that great grumbler, the American farmer, will learn better, and begin ciphering out his problems on his children's slates. He then will demand that, when he pays for phosphoric plant-food to replace that which his wheat or other crops have taken from the home place, he be given, not the name "guano" on lime or sand, not lamp-black and a smell as at present, but available phosphoric acid, and will hold the manufacturers responsible for its delivery. With that better day of his emancipation from corner-store politics to the liberty of common sense will dawn the real development of Florida and her phosphates, which alone can be used to make what millions will demand and insist that they receive—to replace the 2,714,585,473 pounds weight of phosphoric acid yearly taken from the land in the United States by its cereal crops.

There are many different theories of the source of the phosphoric acid in the phosphates, but to the practical miner little matters except the fact that in some way the phosphoric acid

came, was leached into the limestone, and replaced the carbonate with phosphate, and left him his "hard rock," "gravel," "plate rock," "soft phosphate," "land," and "river" pebbles, which he must properly mine and prepare for market. How to do this is what worries him most and makes a rich harvest for the machinery manufacturers. Roughly speaking, phosphate mining can be divided—as we were taught in childhood to divide the earth—into land and water. The land mining is further subdivided into "boulder," "gravel," "plate," and "soft" deposits; the first being handled as heavy materials must be which need blasting and crushing, to be reduced to sizes which can be handled conveniently; and all methods are but variations of those used in the hematite iron ore workings. The other deposits can be worked more by the wholesale methods of steam shovels or dippers, and even hydraulic washers are successful, as used in the gravel workings of California.

The mining under water follows the lead of that of the South Carolina river mining methods, with all forms of dippers, shovels, pumps, and grapples.

The hard rock or granitic boulder forms are often as beautiful as

MINES OF THE COMPAGNIE DES PHOSPHATES DE FRANCE.

TYPICAL GRAVEL-KILN AND SHED AFTER BURNING.

marble or agate in cross-sections, and the deposits usually begin at the outcrops and run back under the sand overburden to great depths. The overburden is rarely taken away deeper than fifteen feet, but profitable mines have been at work in sixty feet of high-grade rock. The Dunnellon Phosphate Company has removed over 60,000 tons from one open cut of an acre in extent. The deposits are pockety in all cases, being from a few square yards in extent to three acres, the size being often in inverse ratio to that of the out crop.

Liebig has said that "a nation's civilization may be estimated by its consumption of sulphuric acid." Dr. Charles U. Shepard gives the following valuable table as the world's use of commercial fertilizer,—that sponge which absorbs so much sulphuric acid:

	Tons.
United States	1,550,000
Germany	1,300,000
France	1,000,000
Great Britain	1,000,000
Belgium Holland (estimated) 300,000. Scandinavia " 100,000. Spain, Italy, Austria	650,000
Total	5,500,000

Thus we see that, according to the test of the first authority, America would lead the civilization of the world. To the making

WASHERS, COMPAGNIE DES PHOSPHATES DE FRANCE.

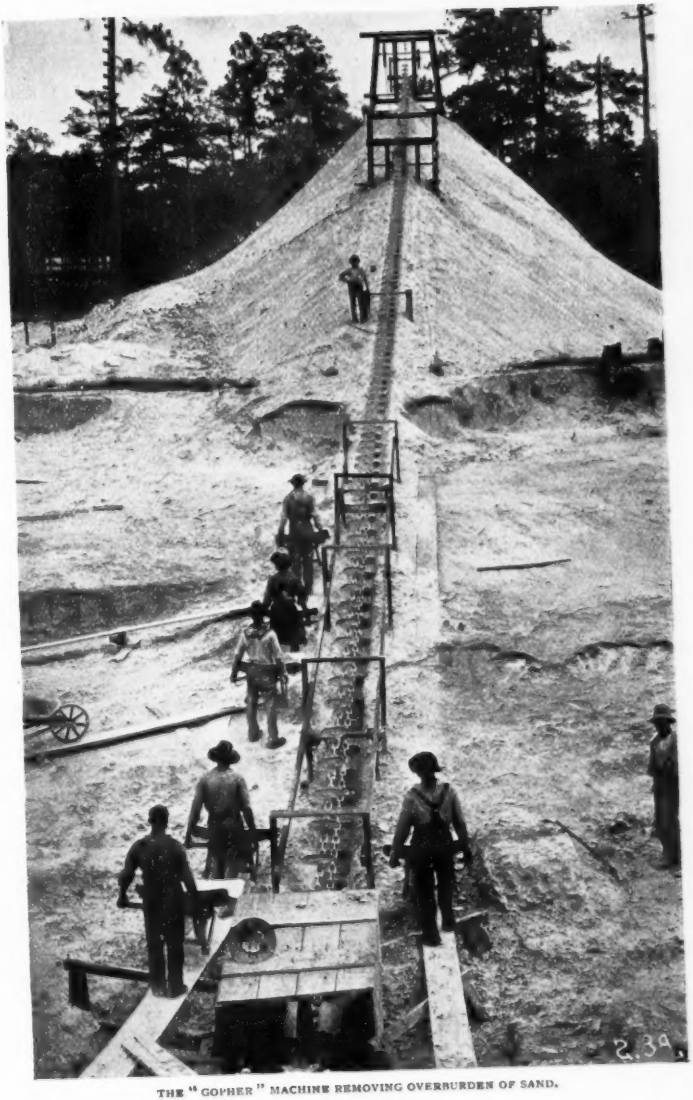
A DEEP MINE.

of this vast total the following countries contributed, in 1891, by the tables of Mr. Hermann Voss :

	Tons of 2240 Pounds.
France (Somme and Ardennes)	400,000
Belgium (Mons and Liege)	200 000
West Indies (Aruba, etc.)	50,000
Canada	20,000
Germany (Lahn)	40,000
England (Coprolites)	20,000
Russia, Norway, and other countries	100,000
Total	830,000

This does not include the United States, which, for that year, produced 757,133½ tons of phosphates. The figures are extremely interesting, and since that day there has been dumped into the nearly-balanced scales the great increase of the output of Florida ; and the preponderating influence in the markets of the world has come across the waters to American mines on account of this new mining State. But by forcing her way into the scales Florida rock has suffered the consequence and, naturally, gone down in price.

Before me lies an account sales rendered to a Florida mining



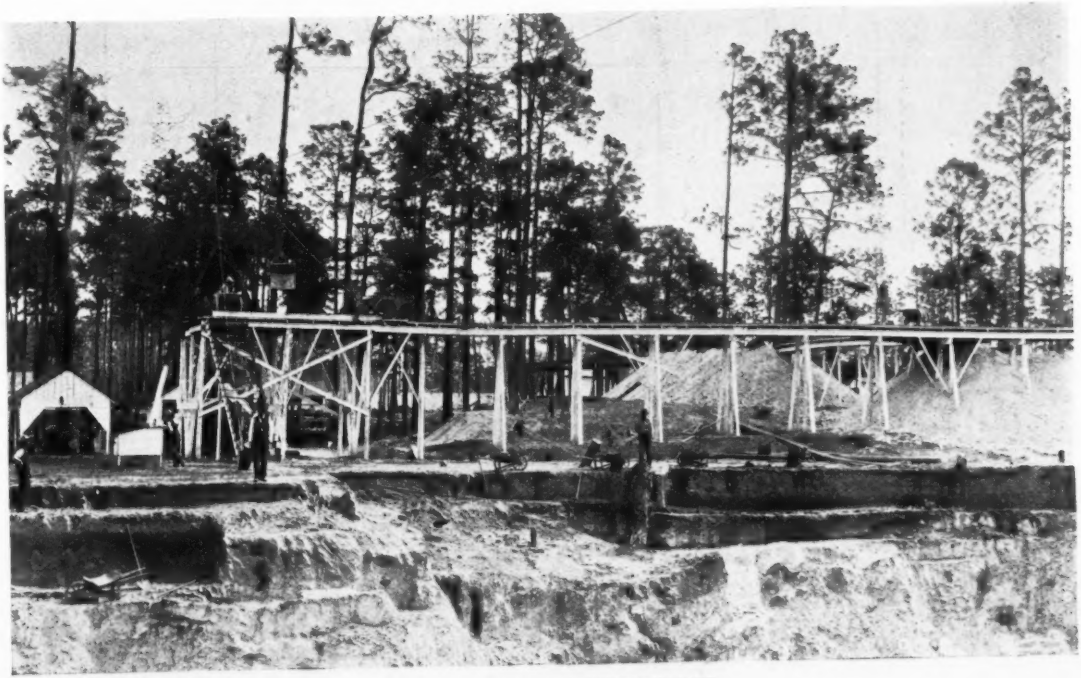
THE "GOPHER" MACHINE REMOVING OVERBURDEN OF SAND.

company in the early days of the industry. The rock yielded, by analysis, about 78 per cent. phosphate of lime, which brought, at that time, 25.34 cents per unit. Thus for the total of a small cargo of 1104 tons the gross result was $32,761.17, making net proceeds $22,241.45, which is not half bad. And yet when the rock was first sold in the European market it brought 30 cents per unit.

The London market now yields 17 to 18 cents per unit, which nets the miner from $5 to $6 on the cars at the mine. To meet this sudden drop in the scale, and yet live, has been the problem of the field. At first we saw hundreds of thousands of dollars recklessly thrown into plants whose washers, driers, cableways, engines, and houses were found totally impracticable, and were soon abandoned. It speaks well for the industry that it has lived and thrived even against odds which would have killed any business that did not have the elements of a most vigorous growth. For instance, the output of one mine was 25,000 tons one year, and in that time the salary-roll reached $50,000, and machinery and prospecting each cost as much more.

The business is not old enough to have developed any one method as the most profitable in all respects, so that each mine has its own individuality and peculiar method of working. In the field are miners and companies from France, Canada, Germany, England, Spain, Holland, Belgium, Algeria, Norway, and all parts of the United States. All systems are in use, from the negro with his "buggy"—as he calls a wheelbarrow—to the complete plant, where the rock is not touched by hand from the time it leaves the pit until it is in the box-car,—washed, dried, sorted, and ready for the Hamburg manufacturer of superphosphates.

There is no sign of exhaustion in the deposits. Florida rock has crushed the Spanish phosphate industry and also that of Canadian apatite-mining, which once were the only sources of that high content of phosphoric acid essential to the manufacture of the high grade of fertilizer demanded by the educated European farmer. The United States government experts estimate that the South Carolina mines, which have made Charleston the financial hub of the south, will become exhausted in twenty-five years. Though they unfortunately estimated the number of tons in sight in Florida at 133,056,416, it is fortunate that the whole State is not solid phosphate, as was believed by those who went crazy in the "boom" of 1890. After all, there is enough here to give her an income suited to a princess of phosphate States, and that for centuries to come.



THE WIRE-ROPE TRANSPORTATION SYSTEM IN USE.

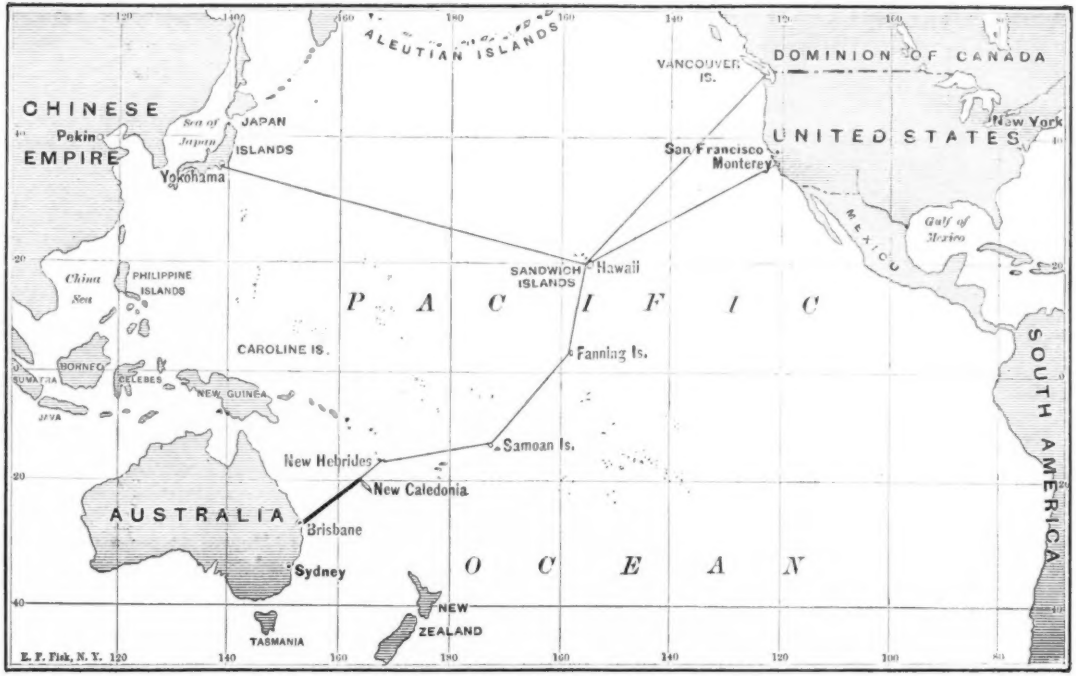


CHART SHOWING ROUTES OF PROPOSED PACIFIC SUBMARINE CABLES.

[The heavy line leading from Brisbane indicates a section of cable now in operation.]

PROPOSED CABLES UNDER THE PACIFIC.

By Herbert Laws Webb.

CABLE-LAYING contractors have for many years cast longing glances at the Pacific ocean,—the one great gap in the submarine-cable system of the world. From the contractor's point of view the laying of a cable across the Pacific would be a splendid job, provided that a company of unquestionable financial responsibility were in the position of "the party of the first part." The party of the first part has not yet appeared in a really satisfactory guise, and the Pacific cable so far has only found an easy, though unproductive, resting-place in the columns of the newspapers. Lately, however, a beginning has been made,—at the wrong end of the line, it is true, and of insignificant size, but still it is a beginning,—and many signs now point to the completion in the near future of a Pacific cable.

It is safer to say *a* Pacific cable because, although it has become customary to speak of *the* Pacific cable, the routes and termini proposed by the different nations and individuals interested offer as much variety as is found among the routes and termini of the cables that cross the north Atlantic and south Atlantic between the American continent and Europe and Africa. For example, Vancouver and Monterey are almost exactly as far apart as Valentia and Lisbon, the European termini of the north and south Atlantic cables; while Yokohama and Brisbane, both proposed as termini of "the" Pacific cable, are a great deal farther apart than Heart's Content and Pernambuco, the American termini of the north and south Atlantic cables.

As matters now stand there are really two distinct schemes on foot for cables across the Pacific: one, which may be called the American plan, for a line from California to Japan, via the Sandwich islands; the other, which may be called the British-Canada-Australian plan, for a line from Vancouver to Australia, via the Sandwich islands, and the Fanning, Samoan, and Fiji islands. In this latter route the Canadian government and the Canadian Pacific railway have interested themselves and have endeavored to interest the Imperial government and those of the Australian colonies, though so far without much success. The first plan was originally

proposed by the late Cyrus W. Field, shortly after he had successfully promoted the first Atlantic cable, and when, like a marine Alexander, he was looking about for other seas to conquer. Ordinary coastwise cables, useful as they are in many parts of the world, were beneath Mr. Field's notice; he looked to mooring the New World to the Old on both sides, and his proposition was really a combination of the two schemes just specified. He laid out a plan for a line from California to Hawaii, and "branches" from the latter point to Japan and to Australia, comprising in all about 17,000 miles of cable, or more than two-thirds as much as is now contained in all the systems of the North Atlantic service, with their many branch connections.

The two schemes, which for brevity's sake may be called the "American" and the "Imperial," in all probability will both be carried out. From a practical point of view it is quite certain that a single line over such an extremely long route would be unsafe. The first requisite in a telegraph service is permanence, and a service depending on a single line 7000 miles long could never be permanent. The only safeguard against interruptions is a duplication of cables, and the longer the cables the more important becomes the necessity of providing against a break-down in the service by the interruption of one cable. Whenever, therefore, a single line of cable is laid across the Pacific, it must inevitably be followed by a second line,—either a duplication of the sections of the first or a line with different termini. In no other way could a traffic be built up and held against the competition of the existing routes to the same points, which practically are never interrupted. There is no reason, therefore, why Pacific cables should not eventually be laid over both the American and the Imperial routes.

It is worth while to look for a moment at the two routes in detail. In the general newspaper discussion it has not appeared to matter much whether Yokohama, Brisbane, or Auckland were picked out for the distant terminus of "the" Pacific cable. In practice it would matter very much, as there are now more than 3000 miles of cable between Japan and Australia, and the extra rate on messages for Japan via Australia or *vice versa*, over the rate for the Pacific cable itself, would make a very material proportion of the total cost per word. Another argument for the advantage of laying cables to both points is that between Australia and Japan messages would undergo innumerable transmissions, greatly increasing the delay and the chances of mutilation.

From every point of view the Imperial route is the most attractive one. Apart from the question of joining the colonies together, it has the distinct advantage of containing a greater number of sections, which renders the line easier to operate and also gives greater opportunities for picking up traffic and subsidies. The Imperial route has five sections, none of them of extraordinary length. The American route has only two sections, one of which is of extraordinary length. The section from Hawaii to Japan will be over 3400 miles long,—nearly a thousand miles more than the longest of the Atlantic cables. Such a long cable would be expensive to operate, as the transmission would be comparatively slow, and interruptions would be very costly because the delay in effecting repairs would necessarily be great. Another difficulty is that the bottom of the ocean off Japan has a bad reputation, though possibly this will disappear before the light of a detailed survey. In spite of these obstacles that appear at present the cable will doubtless be laid ; before very long it will be a necessity of commerce.

There has been considerable discussion as to whether Vancouver or Monterey should be the eastern terminus of "the" Pacific cable. It is pointed out on the one hand that for "strategic" reasons Vancouver is preferable for the Imperial route, while as regards actual economy Monterey has the palm, as the section between Monterey and Hawaii would be at least 400 miles shorter than that between Vancouver and Hawaii. A great deal of nonsense is written about the "strategic" value of a direct line between Canada and Australia. It is nonsense because, without a line across the Pacific, there is excellent telegraphic communication between Downing street and Canada and between Downing street and Australia, and when Downing street wants to telegraph there is no anxious consultation of the tariff-card to see how much the rate is. Such talk is nonsense, again, because the "strategic" value to Great Britain of a cable across the Pacific,—*i. e.*, its value to her in time of war,—would be greatest if it were entirely owned and controlled by Americans or other neutrals. Were the cable under British ownership and subsidized by the Imperial and Colonial governments it would be cut by the power with whom Great Britain might be at war, as quickly as it could be got at, treaties notwithstanding.

The strategic value of the control of the landing-place of a cable when the rest is so vulnerable would be about on a par with the strategic value of the possession of a railway terminus when

the enemy could pull up the tracks. It is well known that in 1885, when there was some little friction between Great Britain and Russia, the Russian government prepared a fast vessel with an elaborate equipment for ripping up the numerous submarine cables that radiate from London all over the world, and link British outpost with British outpost. Treaties so often become warped even on land that under the influence of sea air they would lose all shape and meaning, and the "strategic" value of a submarine cable to the power controlling it is likely to be much overestimated.

Of course this does not mean that the importance of having good cable communication with outlying places in times of peace is not of sufficient weight with the governments interested to encourage the offering of good subsidies in the case of the Pacific lines. The fact that those lines would not have the strategic value to the Imperial government that has been so freely attributed to them is only one of the factors that have prevented the project from assuming more active form before the present time. The retarding influences have been various. The principal one is, of course, the enormous cost of a system of cables that would insure permanent communication. The length of cable necessary to construct a line from Vancouver or Monterey to Brisbane is, in round figures, 7500 or 7000 miles,—the higher figure for Vancouver, the lower for Monterey. The lowest price at which an Atlantic cable has been laid is about $1000 a mile. To lay cables across the Pacific would cost rather more on account of the greater distance from the seat of cable-manufacture. The capital necessary for a single line, therefore, would be nearly $10,000,000, and, with duplicate sections, without which the venture would be of a most uncommercial nature, nearer $20,000,000. Private capital alone naturally hesitates at such a plunge, although private capital has long been willing to take it with the support of government life-belts.

The government life-belts so far have not been forthcoming, although applied for in various directions, and capital has lingered coyly on the shores of the Pacific. It has been difficult in the extreme to secure united action, or even united interest, on the part of the various Colonial governments in the face of the lack of interest on the part of the Imperial government. The project, too, has been fought by the "cable ring," which controls by far the greater proportion of the world's submarine cables, with all the ferocity, with all the far-reaching manipulation, of which that body is capable. I have heard of no business competition so vindictive

and so—peculiar in its methods as that practised in submarine cable circles. It would probably astonish my readers, and lead to a suit for libel against the English publisher of this Magazine, were I to relate some of the "strategies" by which competition in submarine-cable laying and working has been accomplished. No doubt much of the opposition and lethargy with which the Pacific project has been met could be accounted for by those interested in existing lines of communication.

However, in spite of all the difficulties real and apparent, in spite of all the opposition active and latent, the Pacific cable system will soon be in existence. There is a real demand for it, for one thing, and there is every prospect of a satisfactory and growing traffic. The necessity for the section between California and Hawaii has been obvious and pressing for some time past. Had the cable been laid a year or so ago the whole Hawaiian fuss would most probably have been averted. The saving in printer's ink and type-metal, to say nothing of editorial, repertorial, and governmental time, would have more than paid the cost of laying the cable. Had the excitement occurred in spite of the cable it would have provided paying business for the cable during all this time. The Fifty-first congress had an opportunity to ensure the laying of the cable in 1891 by granting a subsidy. It made an appropriation for a survey instead. Probably before now the Fifty-first congress has wished it had made arrangements to have the survey and the cable too. From reading the head-lines of various newspapers I am at a loss to determine which party to the many-sided dispute would have found the greatest "strategic value" in the cable had it been in working order during the past year. Certainly its value to a public already overburdened with other worries would have been sufficiently great, as cable messages are generally terse.

It is a trite and inaccurate saying that "trade follows the flag." It would be much truer, and certainly newer, to say that trade follows the cable. Of course there have been many cases where the trade was already active, with abundant traffic ready to flow into the cables the moment they were laid. But there have been many others where, languid and intermittent until the cable stretched out its encouraging and far-reaching grasp, trade has rapidly and steadily increased under the subtle influence of instantaneous communication with the markets of the world. Many instances of this could be cited, and it is an unquestionable fact that submarine cables, like long-distance telephone-lines, make their own traffic by

creating new ways of doing business. In the case of the Pacific cables the places now without communication that will be opened up are of relatively insignificant resources, excepting Hawaii, and even Hawaii in ordinary times will not keep a cable busy all day. But in the aggregate the different intermediate points will probably make a fair showing and whatever traffic they furnish will surely show a steady increase.

The Pacific cables, however, will find their principal traffic through providing a more direct route between Australasia and the American continent. There is already considerable trade between this country and Australia, China, and Japan, and more direct communication cannot but give that trade a great incentive. Cables connecting America with Australia and Japan will give her quick communication besides with the Straits settlements, the Philippines, China, Siam, Tonquin, India, and Asiatic Russia. They will provide an alternate route from Great Britain to the extreme east and Australia, and other sources of traffic will be found in Canada and South America. The completion of the trans-Siberian railway, opening up communication across a vast tract of most varied resources, will introduce an important change in the channels of commerce in the part of the world that the cables will draw on for their traffic.

A word as to the practicability of the Pacific cables. The only part of which a detailed survey such as submarine-cable engineers nowadays exact has been made is the section between California and Hawaii, which has been surveyed by the United States government. The soundings made by the *Tketis* and the *Albatross*, while showing a slightly greater depth than that of the north Atlantic, have revealed no other difficulties. The banks on the line have been surveyed in detail and a practicable route laid down which shows a far more even bottom than that of the mythical north Atlantic "telegraph plateau." Captain Maury's "telegraph plateau" was outlined before deep-sea sounding had become an exact science. Since the laying of the early Atlantic cables closer surveys have discovered three important banks along the line of the "plateau" that materially disfigure the even profile it presents in the imagination of the majority of newspaper-readers. The really beautiful profiles of the Pacific from California to Hawaii that accompany the elaborate report of the United States survey show a bottom that is a delight to the submarine-cable engineer; all he could wish is that the whole of it were a little nearer to the surface.

The great depth is after all not very much of a difficulty, when the evenness of the bottom and its favorable composition—principally brown ooze and globigerina—are taken into account. Depths as great as the average of those determined in the Pacific survey are found in the north Atlantic, and especially in the south Atlantic. I know of a cable in the south Atlantic, in practically the same depth of water, that has been down for over ten years without a single interruption—and it was laid over a bank at that. The bank was missed even in a very careful and detailed preliminary survey, and was discovered while the cable was laying in sufficient time to save the situation by paying out extra slack. A large portion of the Pacific, west of the Hawaiian islands, has not yet been surveyed with any detail. There are stories of abnormal depths in these waters, probably due to drifting of the sounding line, and, as pointed out before, the seas in the neighborhood of Japan and Australasia have a suspicious reputation. They have given good (or rather bad) ground for their ill-fame from a submarine-cable point of view by occasionally shifting their bottom in a surreptitious manner. This is more than a cable can stand, and several serious interruptions have been caused by these submarine earthquakes.

It is interesting to note, in closing the subject, that a beginning has already been made, in a small way and at the distant end of the line, by the laying of a cable from Queensland to New Caledonia. This has been laid by a French company—the Société Française des Télégraphes Sousmarins—with the assurance of subsidies from the colonies interested. The cable company proposes to lay further sections to the Fijis, Samoa, the Fannings, Hawaii, and California, and is agitating for subsidies in competition with the promoters of the American and Imperial schemes. This enterprise illustrates an interesting phase of submarine-cable work. The few contractors who engage in making and laying cables are often driven, when legitimate orders hang fire, to promote telegraph schemes themselves in order to make work for their factories, fleets, and staffs. The French company is peculiarly in this position. It was started with the capital set free by the purchase by the French government of the Paris telephone system, and a large amount of money was spent in an elaborate factory at Calais, a ship and so on, reliance being placed on steady orders from the French government. This august body, exercising the privilege of governments, proved fickle to its promises or assurances and the

company, being unable to compete in price on open tenders with the English cable-manufacturers, finds itself in the position of being obliged to make business for itself. Hence its appearance in the Pacific. If it be true, as stated, that this company intends to complete the line from Queensland to California on its own account (failing subsidies), one cannot but admire the company's courage. It is magnificent, but it is not business, although it may turn out to be very good business in the end—for somebody.

To sum up, there can be little doubt that the Pacific will have its net-work of cables within the next few years. Asia will be moored to America; Puck's girdle will be complete.

PRECAUTIONARY HINTS FOR INVENTORS.

By Frank Richards.

GOOD advice is the cheapest thing in the world, especially when the quality is considered. Though always a drug in the market, the production still goes on, and it is not in human nature to allow any of it to run to waste.

The United States is the land of many inventions. The remark has been made before to the glorification of American ingenuity. The inference may be correct, but the evidence does not warrant it. The greater opportunity and the greater incentive to invention here would seem to be sufficient to account for the phenomenal activity. The fact that inventions are better protected here than elsewhere, the fact that inventions are reputed to pay well, makes every man a would-be inventor; and the final result is that while the United States is, as loudly claimed, the land of the successful inventor, it is also—alas!—the land where the unsuccessful inventor abounds. Any one who knows much about patents can recall a hundred unsuccessful ones for one that has had any measure of success, or that, as we say, has paid its expenses. Besides the unsuccessful patents we must reckon, to get a true view of the shady side of the case, the vast numbers of rejected applications for patents, and then we may look over the horde of deluded unfortunates who waste their days and their nights, their money, their friends, their hopes and their lives upon worthless schemes that never reach the doors of the patent office. Oh, yes, we are a nation of great and successful inventors. We reap a rich harvest of golden grain; but the stubble and the straw and the chaff encumber the ground.

But why do so many inventors fail? It is not difficult to shape an answer that will cover every case. They don't have a successful run because they stumble over an *if*. Sometimes the "if" is a little one, sometimes it is a big one, sometimes there are more than one in the way; but little or big, one or many, an "if" is as inevitably fatal to an invention as a drop of oil is to a spider. The writer remembers how, once upon a time, in one of the cities of the Empire State, an ingenious and persevering colored man was chasing mayor and aldermen around town with his drawings and specifications of a proposed device for stopping runaway horses.

The invention contemplated the erection, at each street-crossing, of a couple of stout posts, around one of which was to be coiled a wire fence long enough to reach across the street. If a runaway should occur it would only be necessary to run ahead of the horse and unwind the fence and hitch it to the post across the street. It is perfectly evident that this device would stop the runaway every time, if—. In fact, it is to be supposed that every invention would be a success if it could satisfy a big enough "if."

About this time we are to expect the device for melting the snow in the streets. The cuts and description have lately been published of an elaborate machine for this purpose. It is claimed that the machine, employing thirteen men to serve it, will melt 1000 cubic yards of snow in ten hours, with a consumption of 200 gallons of naphtha, and with a total operating expense of $37, allowing nothing for repairs and maintenance or for original cost of plant. The writer has taken the trouble of making some rough computations upon the estimated performance of the machine and is not prepared to concede that it will do more than one-half of what is claimed for it; but, assuming that it will do all, the claim will bear looking into a little. One thousand cubic yards of snow would be about the average amount to be disposed of upon one wide street for the length of one city block after a snowfall of one foot. The water would weigh seventy-five tons. After a good heavy snowstorm, when the snow must be disposed of as speedily as possible, at least a thousand of these machines, with crews amounting to 13,000 men, and, say, one thousand "supes"—all voters—would be required to make any respectable showing in New York alone. After a "blizzard" the machines would be of no use at first, when most needed, because they would not be able to "get there." It is to be feared that *if* will be too much for this invention. Any one who has ever undertaken to get enough water to do a family washing by melting snow in a wash-boiler over a red-hot stove is not likely to be found inventing an apparatus of this kind, or even holding any stock in it.

There is no unkindness or injustice in the sharpest criticism of any invention that challenges our attention, provided that the criticism be honestly given, and that it be based upon sincere and intelligent conviction. Where a thing is a self-evident and inevitable failure the mistake and the cruelty of silence rather than condemnation, though often practised in such cases, means only the attempted prolongation of a necessarily mortal agony.

The fact that a man sets himself up for an inventor, or assumes that he is one, affords no presumption as to the fact. I have had a man talk to me as much as would fill two pages of this Magazine to explain how a rack and pinion works, and I actually believe that he thought while talking that he had invented that mechanical movement. It is well-known to any one who has had much experience in mechanical lines that there are very loose ideas widely spread as to what constitutes an invention, and it is notorious that many of the inventions of the age, and often the commercially successful ones, are not the product of their supposed and accredited inventors. The writer was connected for some years with a well-equipped model-making and experimental machine-shop, where many mechanical inventions were perfected and knocked into practical shape. Some of them were more than perfected. The shop attained—and maintains—locally, at least, quite a reputation for its facilities in this line, and inventors would sometimes come there with a bare idea that a machine might be made to accomplish a certain purpose, but without a shadow of an idea of how it was to be done, and often without a mechanical idea of any kind, and they would go away with the perfected machine and swear to every detail of it, upon which a patent claim could be allowed, as their invention, and get the patent, when in some cases they were almost incapable of understanding the operation of the machine. I could tell how a quite complicated and reasonably successful machine was invented and made up, one movement after another, after daily sessions continued for some months between say, Jake, the "inventor" of the machine, and Aleck, the designer and draughtsman of the establishment, and while the machine was in progress I have more than once heard Jake remark, concerning some movement involved in it, "Well, if that device won't do it Aleck must get up something else that will"; and of course Aleck did get up something else when it was needed, and of course Jake went before the patent office as sole inventor and got his patent unchallenged. Now I am not saying that there is anything wrong in all this, except in the looks of it, and a mere matter of taste is not a thing to quarrel about. It is good for the public that Jake and Aleck got together, and it is to be supposed that they were glad to meet each other. The greatest good of the greatest number does not always mean exact justice to everybody, however.

Inventors looking for success need constantly to be reminded of some of the conditions upon which alone it is to be attained

The "business end" we so often hear of is the principal end. It is, in fact, both ends, and includes the whole. In old times, in the shop, when a gang was called to carry a heavy bar of iron, I always liked to get in the middle of it, because I knew that if the ends were kept up I would surely be all right. I was wiser in my generation than the average and typical inventor. He tugs away at the middle, indeed, but he leaves the ends unprovided for. It seems almost absurd to have to tell an inventor that it is fatal to neglect or despise the business end. Such a neglect should be taken as a reproach upon the actual inventive skill of the inventor, and involves in fact a leaving out of an essential part of the actual invention. It is not an improved valve-motion that you are trying to invent, and you know it. You are really trying to invent a thousand dollars or ten thousand dollars, and if you don't get the money it would be absolutely correct, as far as your original intentions are concerned, to say that the valve-motion does not work, no matter how correct mechanically and admirable otherwise it may be. The successful inventions of the age have been more notable as business successes than as mechanical achievements. The Corliss engine might quite possibly have died unknown but for bold and novel and correct business methods for pushing its sale. The Westinghouse brake is another notable business triumph. The marvelous genius of Edison only makes things possible; it is business organization that brings them to man's use and enjoyment.

I may now say a word or two about the most prominent invention of the year 1893, premising it all with the remark that it was not in a correct sense an invention at all, and that it was not invented by the reputed inventor, but that it well illustrates the supreme importance of attention to business. Of course the biggest thing of the year was the World's Columbian Exposition, and the biggest thing of the Exposition,—the thing most widely known in connection with the Exposition, the thing that you would first and instinctively suggest as most prominent, the first to leap to your lips when challenged,—was the Ferris wheel. Now it is telling no secret and betraying no confidence, it is with no intention of stirring up jealousies that do not exist or making any kind of trouble in the family, that I call attention to the fact that the Ferris wheel was not the creation of the Ferris brain. There was nothing that we think of as pure invention in the wheel; there was no new principle and no new application of known principles. Its construction was the successful solution of a problem of design

difficult only by reason of the size and weight and strain involved. The material used was such as in these days is readily available to the hand of every constructive engineer. The greatest achievement of engineering was in the financial engineering, and that principally at the beginning of the undertaking.

The most difficult, if not the only, bit of actual invention involved in the whole undertaking was in the devising of the necessary formulæ for calculating the strains upon the wheel and for proportioning the several parts to sustain them. The work of computation, of designing the structure and the operating machinery, and of supervising its construction and operation fell upon the shoulders of Mr. W. F. Gronau, a young graduate in civil engineering of the Rensselaer Polytechnic Institute. It is not necessary to say that the shoulders sustained the load with eminent success. The labor and responsibility was not small for a young engineer or for any engineer in the world. Mr. Gronau, in his account of the first trip of the Ferris wheel, at which it appears that Mr. Ferris was not present, quite naively says: "Much credit is due Mr. Ferris for valuable suggestions offered in the designing of the turning-gear and machinery, for obtaining the concession from the World's Fair management, and for successfully managing the financial end of the wheel."

And yet it remains to be said, and it is for every inventor to note, that the wheel would not have existed but for Mr. Ferris, while Mr. Gronau's work might have been done by somebody else.

The ideal inventor is a well-informed and well-equipped man all around. I have known some inventors who have had the pushing business faculty in excess; and who were over-balanced and top-heavy in that direction. Some of them have pushed things into prominence and notoriety that ought to have been pushed into the ground, and that eventually got there. Visionary and loud-talking inventors, some of them honest enough, some of them not honest enough, often entrap and victimize confiding capitalists, and the whole race of inventors is exposed to suspicion and rebuff in consequence. There are many inventions to be developed, not necessarily the most difficult ones mechanically, that are too big to be handled by a man without capital. The capitalist who has been burnt once or twice will not risk getting scorched again, and so the honest inventor may not get the help that he deserves, the public may not get the improved service that they deserve, the capitalist may not get the profitable investment that he deserves; the blight-

ing inventor that has gone before has turned the whole blooming field into a desert where no man gets his deserts.

Just now the Metropolitan Traction Company is offering a reward of $50,000 for an improved and acceptable means of street-car propulsion. Of course the reward offered is liberal, but it is still very small as compared with the standing offer that exists in the circumstances of the case. There are possibly millions in it, as every intelligent man knows, but the offer of ready cash will act as a stimulus and will spread wide as an advertisement. But it is not every high-mettled inventor, or even probably the ablest and most deserving one, who can build street-cars and the whole system of propelling machinery involved in the experiment and the successful demonstration, and if he cannot secure the coöperation and support of men of means he may invent until doomsday and none be the wiser or better.

Say that the inventor is confident that he can propel street-cars successfully by compressed air, better and more cheaply than by any other means (and the writer hereof has the fullest faith in that direction), and say that, inspired by his belief, he solicits the coöperation of the capitalist. He finds the man of money fully armed to repel him and a ready weapon in his hand. Your capitalist has no mechanical knowledge, and cannot judge by that means of the schemes that are presented for his consideration; but he has a quick and unfailing memory for undertakings that have failed, and a word can recall a bitter experience. You talk of compressed air. Why there was a pneumatic street-railway company that only a year or two ago made a big splurge and raked in a pile of money—at one time, I am credibly informed, they had three hundred thousand dollars in cash in their hands—and they ended with a shameful and disgraceful fizzle. Though that so-called "pneumatic" system was pneumatic only in name all who had any stock in it have probably had all the compressed air that they want.

Still success succeeds, and the art of it has not yet perished from the earth. Inventors must fill their minds fully with the idea that the introduction of their invention is a part of the invention, and the means of accomplishing it are as much or more to be studied and sought for than the wheels and levers and toggle-joints. The art of making friends and of inspiring confidence should belong to those who most deserve them and every man should look out keenly for his rights. It is not best that a just man should be just last of all to himself.

THE AMERICAN PRACTICE IN SILVER-LEAD SMELTING.

By Walter Renton Ingalls.

ONE of the most important factors in the great increase in the production of silver in the United States during the past ten years has been the improvement in the silver-lead smelting-works and their processes, which, together with the extension of railways through the Rocky mountains, has made it possible to treat ores that formerly could not be mined at a profit. The advance made in this direction has been so far-reaching in its results that the methods of silver-milling, like amalgamation and lixiviation, which belong distinctively to the metallurgy of silver, have fallen off notably in relative importance, and now more than half the silver turned out in the United States comes from argentiferous lead-ores and those smelted with them. On the other hand, the lead industry has become more interwoven with silver-mining, until, out of the 620,000 metric tons of the baser metal that were produced in the world in 1892, much more than half was derived from silver-bearing ores. In the United States alone the percentage was higher, only about 20 per cent. of the whole product coming from the producers of soft lead in the Mississippi valley.

The silver lead smelting industry in the United States is of comparatively recent origin, the first successful works having been erected in 1867 at Argenta, Montana, where argentiferous galena ores were reduced in small blast-furnaces, each furnace treating from two to five tons of ore per day. Two years later the great silver-lead deposits of Eureka, Nevada, were opened, and furnaces were erected at that place. In 1870 works were established at Salt Lake City, Utah, to treat the ores mined in Bingham and Cottonwood cañons. From these beginnings the American practice of silver-lead smelting has been developed.

The second stage of the industry dates back to the opening of the great bodies of lead carbonate ore at Leadville, Colorado, in 1878, which was followed immediately by the erection of smelting-works at that place, where in 1880 there were thirteen plants in operation (three more being out of blast), which produced 36,000

tons of lead, or nearly 35 per cent. of all that was turned out in the United States in that year. The Leadville works of this time were much superior to those of Eureka and Salt Lake City of ten years previous, a better type of furnace having been introduced and the methods of smelting having been improved; but both the cost of smelting and the losses in metal were still high, and the defects of these works in comparison with the model plants of the present day would be apparent even to the layman.

A noteworthy feature of the silver-lead smelting industry of the United States during the first fifteen years of its history was the multiplication of small plants in the immediate vicinity of important mines. Few of these remained long in operation, owing to exhaustion of the mines near which they were located, or inability to meet the competition of the larger and more economical plants that were built subsequently; and the policy of erecting works at isolated points, or for treating ores of individual mines, is now recognized to be unwise. The ruins of such works that are to be found scattered through the Rocky mountains are monuments to one of the steps in advance in the practice of lead-smelting in the United States.

About ten years ago lead-smelting works were established at Denver and Pueblo, in Colorado, at the foot of the Front Range of the Rocky mountains, and with the growth of these began the third and final period in the development of the industry in the United States. These works were so located that they could command the ores from many districts through the branches of the railway systems at whose centers they were built, and they were thus able to obtain better and more profitable mixtures for smelting than the isolated works in the mountains, which were dependent upon single groups of mines; they had the advantages, moreover, of cheaper labor, cheaper fuel and fluxes, cheaper supplies, and cheap freights on ore from the railways, which were interested naturally in concentrating the industry at points giving them the most carriage. The smaller and less favorably situated custom works could not stand the competition with the new valley smelters, and one by one were forced to close down, with the exception of a few of the Leadville works, those at Salt Lake City, which occupy a more or less central position, and a few others.

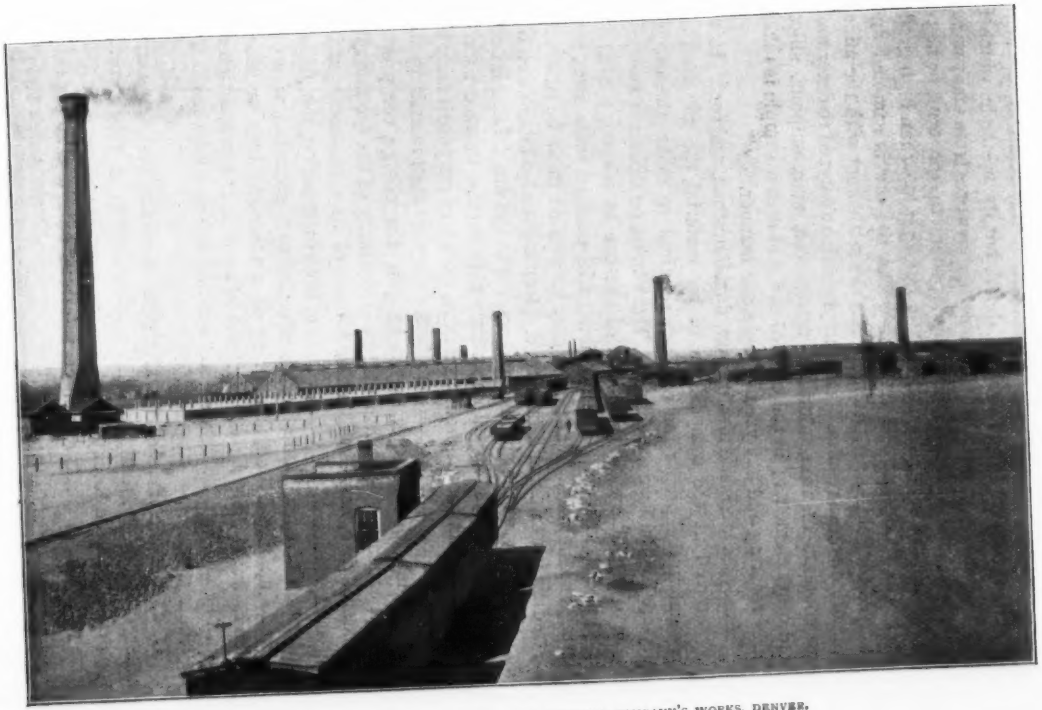
The refiners of silver-lead bullion, established chiefly at Omaha, Argentine (Kansas), St. Louis, Chicago, Mansfield (near Pittsburgh), Newark, and San Francisco, also have smelting depart-

ments, and some of them, especially the three first mentioned, handle considerable quantities of crude ore. There is a close connection between most of the smelting and refining companies, and the base bullion produced by the former is turned over to the corresponding refining-works; so the entire treatment from smelting the crude ore to marketing the refined products is done practically by the same concern. Thus all the bullion of the Colorado Smelting Company, of Pueblo, and the Montana Smelting Company, of Great Falls, goes to the National Smelting and Refining Company of Chicago; that of the American Mining and Smelting Company of Leadville goes to the Chicago and Aurora Smelting and Refining Company of Illinois; and that of the Mingo Smelting Company of Salt Lake City goes to the Pennsylvania Lead Company at Mansfield. The great Arkansas Valley Works at Leadville and the works at El Paso, Texas, are owned by the Consolidated Kansas City Smelting and Refining Company, which refines all its bullion at Argentine. The Omaha and Grant Smelting and Refining Company and the Pueblo Smelting and Refining Company refine their own bullion at Omaha and Pueblo, respectively, and the Globe Smelting Company has recently established a department at its works in Denver for the same purpose. This affiliation between smelting and refining companies, and the erection of refining-works (formerly grouped on the Atlantic coast, with the exception of one on the Pacific) further west, and at the smelting-works themselves, has been one of the important tendencies of recent years, being the natural sequence of the concentration of the smelting-works. All of the refining companies buy also bullion from outside works, including those of the republic of Mexico, about 13,000 tons of bullion from the latter having been desilverized in the United States in 1892.

In theory the smelting of argentiferous lead-ores is extremely simple, but like most metallurgical processes it is more intricate in practice, wherein extraneous complications enter. There are various methods of smelting, but in the United States only one—roasting and reduction—is in common use. The lead in the ore has first to be oxidized by roasting, if present originally in the form of sulphid (galena), but, if already oxidized (as in the case of the Leadville carbonates), of course no preliminary treatment is necessary. It is then charged into a shaft-furnace together with a certain proportion of limestone, oxid of iron, and fuel, which may be charcoal or coke or a mixture of both. The iron and limestone are added to

the ore for the purpose of making a fusible slag. Descending in the furnace the carbonic acid is first driven from the limestone and ore; at a lower zone the charge fuses, the iron and lime combining with the silica of the ore to form a double silicate of iron and lime, while the oxid of lead is reduced by the carbon of the fuel, with the formation of carbonic-acid gas and metallic lead, which collects the gold and silver from the ore and trickles down into the bottom of the furnace, which is called the crucible. The molten slag, being much lighter than the lead, floats on top of it, and is separated by tapping from the furnace at a higher level, the method varying in detail in different types of furnaces.

This is the general principle of the roast-reduction process of lead-smelting, but in practice there are important modifications. Thus part of the lead ore is sometimes fused on a reverberatory hearth previous to smelting in the blast furnace, whereby the lead is converted into silicate, in which form it is charged instead of oxid. Furthermore, it is not economical to oxidize all the sulphid ore, galena, and pyrite, and the furnace charge always contains sulphur. Then there are other metals in the ores, such as copper, arsenic, and zinc, and earthy materials, such as magnesia, baryta, and alumina, which have to be disposed of, and the proportions of iron, lime, and silica in the smelting mixture have to be adjusted so as to effect this. The sulphid and silicate of lead are decomposed by iron with the precipitation of metallic lead. The bisulphids of iron and copper are reduced by iron to monosulphids, forming a matte, so-called. The arsenic also combines with iron as arsenid of iron or speiss. The matte and speiss, both of which carry gold and silver, are heavier than the slag and lighter than the bullion, sinking consequently to a level in the crucible between the two. They are usually drawn off with the slag, however, and separated from it outside of the furnace, after which they are subjected to further treatment (roasting and resmelting) for the recovery of their metallic contents. The earthy oxids, like alumina, baryta, and magnesia, which commonly occur in lead ores, are taken up into the slag as silicates. Zinc, which is the foreign element most dreaded by the lead-smelter, is disposed of in part in the same manner, but in part it is driven off by volatilization. In whatever way it is gotten rid of, however, it leads to increased cost in smelting, wherefore it is customary to make a higher charge for smelting zinc-bearing ores according to the excess in zinc over a certain limit, which may be, for instance, 7 per cent.

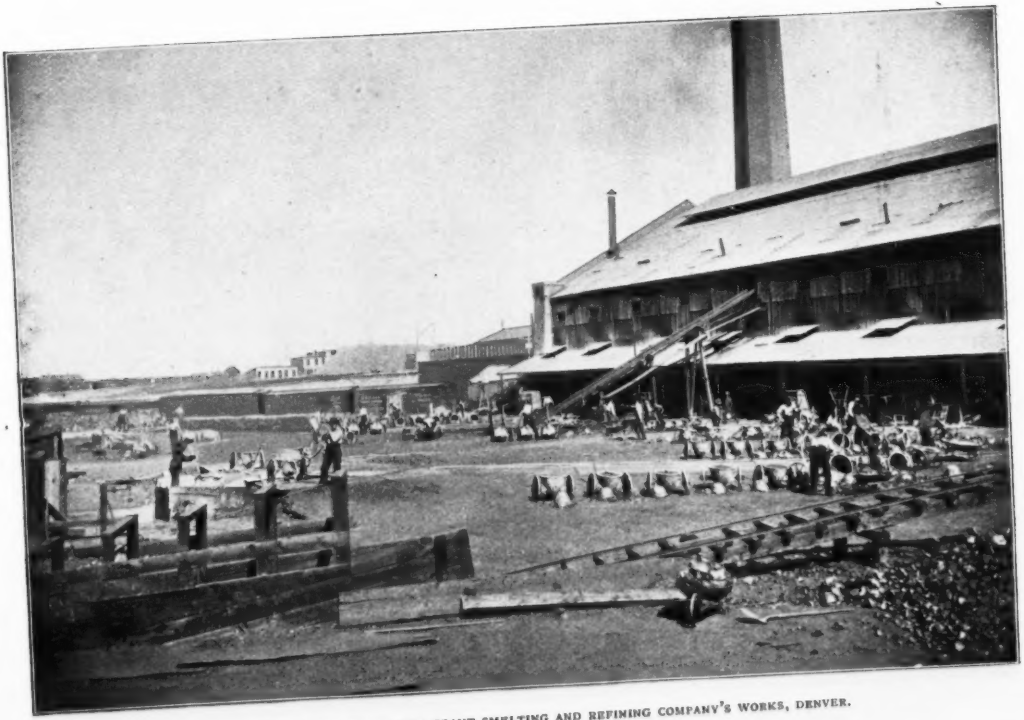


THE OMAHA AND GRANT SMELTING AND REFINING COMPANY'S WORKS, DENVER.

The method of calculating furnace-charges, which is the duty of the metallurgist or superintendent of the works, is too complicated to be explained here in detail, but its principle, which is simple, may be indicated. The smelter buys ores from many mines in lots varying from a few hundred pounds to 100 tons, or more, low grade ore being shipped usually in larger lots than high grade ore. On receipt at the smelting-works the ore is sampled and assayed for gold, silver, and lead, and the settlement with the miner is made on these results. The sample is also analyzed to determine its contents in iron, alumina, manganese, zinc, sulphur, silica, and other elements; in the case of sulphid ores a sample is taken after roasting and analyzed in the same manner.

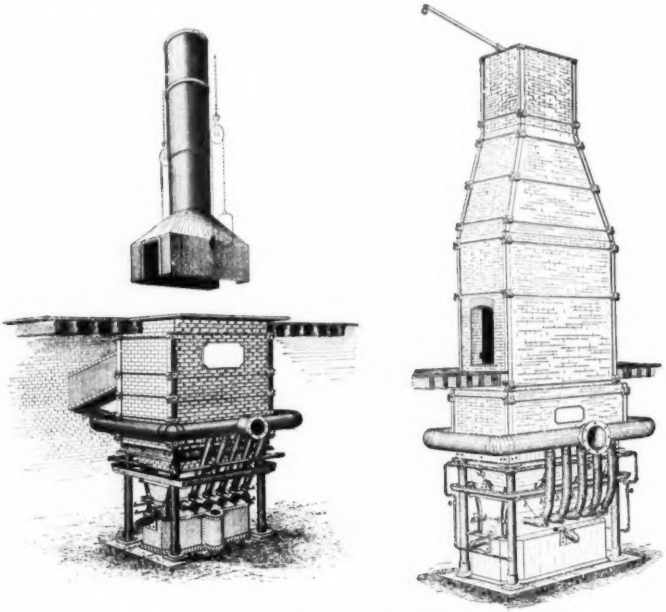
Analyses are made also of iron, flux, limestone, and fuel. Having arrived at the composition of his material, the metallurgist calculates the proportion of each required to make the proper mixture for the furnace charge. There must be sufficient iron and lime to combine with the silica of the ore in making a slag of desired composition. The ore itself will contain some iron, and perhaps some lime. What more may be needed must be obtained by adding iron, flux, and limestone. Iron must also be allowed for combination with the sulphur and arsenic in the ore. Lead is non-fluxing, but plays an all-important part in the furnace as the collecting agent for the precious metals, for which purpose it must be present in a certain proportion; hence the ores used in making the mixture must be selected so as to give the charge the proper amount of lead. The silver and gold contents of the ore must be considered also, in order to make bullion of an economical grade. The composition of the charge having been determined, the proper proportion of each kind of ore is wheeled to a great bin, where it is made up into a bed, amounting to a thousand tons or more, which is drawn upon for the furnaces as needed, the proportion of limestone and fuel being weighed out and mixed with the charge on feeding.

Of course the ideas of metallurgists as to the best slags and other details vary, though within narrow limits. A very general type of slag in the Rocky mountains is a singulo silicate, so-called, with 30 per cent. silica, 40 per cent. ferrous oxid, and 20 per cent. lime. The specific gravity of the slag should not exceed 3.6, in order to have a good separation from the matte; so, although the fluidity of the slag increases with the percentage of iron, the latter cannot exceed a certain limit without danger of loss of silver and



SLAG-DUMP OF THE OMAHA AND GRANT SMELTING AND REFINING COMPANY'S WORKS, DENVER.

lead through its higher specific gravity. The lead in the charge should amount to 12 per cent., although within the past two or three years smelters who used to think they should have 15 per cent. have been obliged to run as low as 8½ per cent., owing to the scarcity and increased cost of lead-ore. The tenor of the charge in precious metals should be such as to make bullion with about 300 ounces of silver and one ounce of gold per ton. A good slag should not, then, carry more than $\frac{8}{10}$ ounce silver per ton, and $\frac{3}{4}$ per cent. lead.



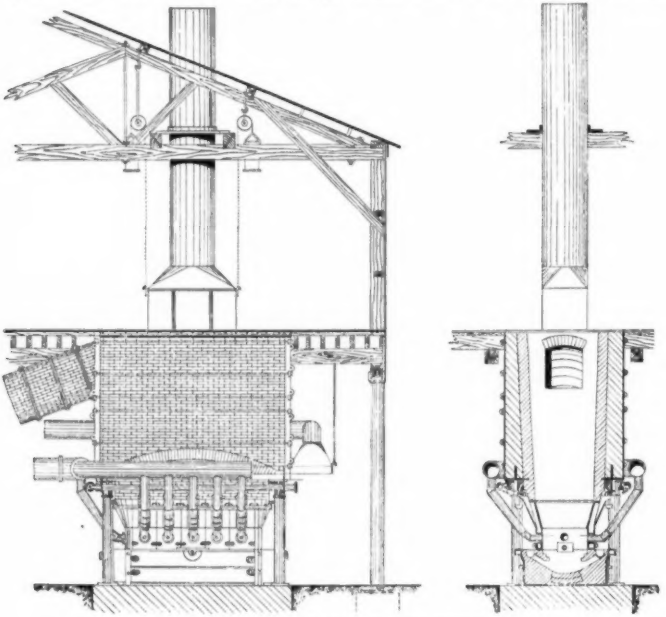
COMMON TYPES OF LEAD-SMELTING FURNACES.

The losses in silver-lead smelting occur in various ways, the most important being in the slag, which, however poor, carries away a large amount of the valuable metals, owing to its great volume. The loss in slag is increased in smelting charges high in zinc, or low in lead, and of course also by irregularities in the running of the furnace. A certain amount of lead and silver is lost, moreover, by volatilization in the form of dust, especially with zinky ores, although a part of this is condensed and collected as

THE GLOBE SMELTING COMPANY'S WORKS, DENVER.

fume and dust in a long series of flues or chambers and subsequently resmelted.

The losses in smelting are taken into consideration, as a matter of course, in buying the ores. Thus only 95 per cent. of the silver is paid for, while the gold brings $19 or even $20 per ounce. The lead is bought on fire assay, which is smelting in miniature and gives results analogous to those of the blast-furnace, but a sufficient discount is made in the rate of payment, based on the New York quotations for refined lead, to give the smelter a safe margin for



A MODERN AMERICAN LEAD-SMELTING FURNACE.

refining and freight to the seaboard. The smelter looks for his profit in the charge for smelting, which varies according to the character of the ore.

The furnaces universally used in the Rocky mountains for lead-smelting are rectangular shafts of fire-brick supported on iron columns which rest on a solid foundation, with a tapering bosh of hollow iron-castings (water-jackets) standing on a hearth of refractory material. Inside the hearth there is a crucible, forming

the bottom of the furnace, connected by a siphon-tap with an external lead-well, into which the molten bullion drains and from which it is cast into bars. The slag and matte are drawn off from the front of the furnace, through a tap-hole, into large pots, where the matte settles while the slag overflows into smaller pots on wheels, in which it is carried to the waste-dump. A series of tuyères enter the furnace at ends and sides, passing through the water jackets and protruding slightly into the bosh. The blast for smelting is thus distributed from a large pipe surrounding the furnace, which is connected with the main-pipe from the blowing-engines. From the top of the furnace above the charging door, the fumes are carried through a large pipe called the "down-comer" or "down-take" to the flue-dust chambers; or the furnace may be quite open at the top, level with the charging floor, in which case the fumes go off through a down-take immediately under the feed floor. The latter style of furnace is the more modern and generally approved.

The modern American lead furnace is from 30 to 42 inches wide, and 86 to 120 inches long at the tuyères. The distance from the bottom of the crucible to the tuyères is 30 inches, and from the tuyères to the charging floor it is 12 to 18 feet, the height depending upon the strength of the blast. As to the latter, some metallurgists advocate a blast $\frac{3}{4}$ to 1 inch pressure of mercury, and others 2 to $2\frac{1}{2}$ inches.

The history of argentiferous lead-smelting in the United States since its inception at Argenta and Eureka has been a record of steady improvement, until at the present time the art has been brought to a higher degree of perfection than exists elsewhere in the world. The first furnaces built, either of the Pilz (round) or Raschette (rectangular) type, were of very faulty construction, and were capable of only a brief campaign, partly on account of the errors in their design and partly owing to the fact that good fire-brick was unobtainable. Charcoal, of inferior quality, was the only kind of fuel used. There were few skilled metallurgists, and even their knowledge of scientific furnace-work was vague, smelting being carried on chiefly by rule-of-thumb methods. Under these conditions it is not surprising that the cost of smelting and losses in slags were high. In Eureka, in the early days, it cost $20 to reduce a ton of ore, and losses of 40 per cent. of the lead and 30 per cent. of the silver are reported.

The first great improvement in the art was the introduction of

the siphon-tap by Albert Arents, which revolutionized the method of discharging products from the furnaces. This was followed in 1876 by the investigations of Anton Eilers, now at the head of one of the largest smelting companies in the United States, on the subject of lead-slags, which was continued by Hahn, Iles, and other metallurgists. Smelters then began to calculate their charges with something like accuracy, and the furnace-running was vastly improved. About the same time came the general introduction of water-jackets, which had been invented some years previously, replacing fire-brick at the smelting zone of the furnace and increasing its life. The construction, size, and form of the furnace had also been improved in other respects during this time, so that the length of campaign was extended and the cost of smelting was reduced. These improvements had all been made before smelting assumed important proportions at Leadville, Colorado, but the work at that place, notwithstanding the easily-reduced lead carbonate ore which its mines were then producing, was very far below the present standard. The cost of smelting in 1880 at Leadville averaged $15.25 per ton, and treatment charges on ore $22 per ton. The average grade of the ore smelted was 69.5 ounces per ton silver and 22½ per cent. lead, about 96 per cent. of the former and 88 per cent. of the latter being saved.

Since the rise of the valley smelters, developments in the lead-smelting industry have been rapid and important. The concentration of works into a few large plants and the handling of larger quantities of ore in each have reduced general expenses; labor-saving devices have been introduced for handling ore, slag, matte, and bullion; furnace-work has been brought to a higher degree of perfection than exists in Germany, where many of our best metallurgists were trained; and the furnaces themselves have been improved vastly in construction and size. Where furnaces 24 inches square at the tuyères, smelting eight or nine tons of ore per twenty-four hours, were used in Eureka twenty years ago, we now have furnaces 120 inches long and 42 inches wide, smelting 80 tons. Instead of losses of 40 per cent. in lead and 30 per cent. in silver, as much as 94 per cent. of the lead is recovered, and it is bad work indeed if 95 per cent. of the silver is not saved—and this with charges running only 9 or 10 per cent. in lead against 40 to 48 per cent. in Eureka. Instead of a cost of $20 per ton for smelting, we have an average in Denver of only $4 50 per ton, for a neutral ore (not including roasting, which costs less than $2 per ton).

The old type of round furnaces, still used almost entirely in Germany, has nearly disappeared in the United States, having been replaced by the modern rectangular furnace, itself the successor of the Raschette. This change has come about because the smelting capacity of a furnace is limited by the distance between the tuyères, which it is agreed should not exceed 42 inches, wherefore a rectangular furnace can be built, obviously, with greater capacity than a round furnace.

Important changes have occurred in the past five years in the character of ores treated. The easily smelted carbonate ores of Leadville have been gradually exhausted, and smelters are now obliged to look for their lead in the sulphid ores of Bingham and the Cœur d'Alene, which require, more or less, a preliminary roasting. The quantity of iron sulphid ores and concentrates in the market also has increased, and this class of ore is bought freely by the smelters, with whom it replaces a certain amount of oxid of iron flux, which has to be brought chiefly from Leadville, on unprofitable terms. Now all the large smelting works are equipped with roasting-furnaces, where formerly they had none, and mechanical furnaces, like the O'Hara and Pearce, are being introduced in place of the old form of reverberatory furnaces; sulphid ores are now the common, and oxid ores the rare, class of material which come to market.

At the present time we cannot see great improvements that can be made in our practice of lead-smelting. The general arrangement of the works is good, and the mechanical devices for handling products seem to be complete. The construction of the furnaces does not seem likely to undergo radical changes unless it is possible, as Professor H. O. Hofman suggests, to substitute some suitable refractory material, such as coke-brick, for the water-jackets, which abstract a good deal of heat. The present state of furnace metallurgy, also, leaves little to be looked for, in these days when fierce competition has forced every man to do his best. Still it can never be said that perfection has been reached, and the future may bring new and important developments, but it may be confidently asserted that the changes in the next ten years will not be so revolutionary as in the last.

THE TEHUANTEPEC ISTHMUS RAILWAY.

By Señor Don Matias Romero,

The Mexican Minister at Washington.

MY desire to comply with the request of the editor to write an article on the Tehuantepec railway, now nearing completion, has determined me to prepare a brief sketch on that subject, though it must necessarily be incomplete. There is not at my disposal sufficient time to collect all the facts of importance bearing upon this road, and perhaps in some instances there may be inaccuracies, as my principal guide in preparing the article has been my personal recollection, which may occasionally fail.

In writing these lines I am guided by a spirit of neither jealousy nor hostility towards the Nicaragua canal. I am persuaded that the canal offering the best conditions will finally be built, and, therefore, that any reasoning tending to disregard this circumstance is idle. If the Nicaragua canal offers the best conditions it will be the first to be built, no matter what reasons or objections may be presented in opposition to it.

I believe that while the Nicaragua canal would offer more facilities than one across Tehuantepec, it would be easier to construct across the latter isthmus a ship-railway, and that the opening of both routes, far from conflicting with each other, would be favorable to the commerce of the world as furnishing two different ways, each with especial advantages for crossing the American continent: Not having myself any pecuniary interest in these schemes, I see them from a higher standpoint, considering only their usefulness to the whole world. I also believe that neither of these works will obtain any pecuniary assistance from the United States, because, in the present temper of the people of that country, no money will be expended in any work of public improvement outside of its own limits.

Great importance has always been attributed in Mexico to the subject of interoceanic communication through Tehuantepec. As far back as the time when Hernando Cortes conquered Mexico and passed through Tehuantepec in his expedition to Honduras, he tried to find a natural pass, like the Straits of Magellan, connecting the Atlantic with the Pacific. Cortes then personally

examined the isthmus of Tehuantepec, hoping to find that passage. Recognizing the important geographical advantages of the isthmus, he believed confidently that the time would come when a route would be established there between the two oceans. The railroad now being built on the isthmus passes through the lands which, on his application, were donated to him by the emperor, Charles V., and which are now divided into three estates called the Haciendas Marquesanas, because Cortes had been made by the emperor Marquis of the Valley. During the three centuries of Spanish domination this project was in abeyance, because the policy of the metropolis was opposed to all communication of the colonies with the outside world, and the opening of an interoceanic channel was directly contrary to that policy.

Notwithstanding that fact,—but possibly in pursuance of that policy, either to find out whether there was a natural passage between the two oceans, with the purpose of closing it, or, if there was not such a natural channel, not to open it, or perhaps desiring a canal for the exclusive benefit of its navy,—the Spanish government caused serious studies to be made with a view to finding a natural passage or to find out whether one was practicable to connect the Atlantic and the Pacific oceans through the American isthmus. Under Philip II. in the sixteenth, and Charles III. in the eighteenth, centuries, careful surveys were made which were remarkable, taking into account the state of science at that time. A complete survey of the Coatzacoalcos river was made in 1610, which, together with a map of that river, was published in the June (1882) number of the *Bulletin of the Geographical Society of Madrid.* The voyage of Baron Humboldt to America, at the beginning of this century, again awakened great interest in this enterprise, as was exhibited by the action of the Spanish Cortes after the Napoleonic wars.

When the independence of Mexico was accomplished the first Mexican congress made, by decree of October 14, 1823, an independent province of the isthmus of Tehuantepec, which then, as at present, comprised parts of the States of Oaxaca and Vera Cruz. The Mexican congress elected to frame the constitution of October 4, 1824, passed a law on November 4, 1824, providing that the executive should call for proposals for the opening of a route across the isthmus of Tehuantepec, and requesting the executive to collect information to provide for the building of a canal.

In my opinion the advantages to result to Mexico from the interoceanic communication had been overestimated, since it was

believed that the opening of a Tehuantepec route would make Mexico the center of the commerce and navigation of the world. Without denying that such communication is bound to produce results favorable to Mexico, especially in developing commerce and industry on her coasts near the isthmus, I believe nevertheless that such expectations were very much exaggerated, and my belief is based on what has happened with the railway across the isthmus of Panama, which has kept open for several years communication between the two oceans. In my judgment the Central American States, in whose ports ply the steamers running between San Francisco and Panama, have been more benefited by that road than Colombia, or even the State of Panama, since they have developed their agricultural production and a prosperous traffic to their great advantage, giving value to their lands, work to their people, and a remunerative result to their enterprises, while no marked advantage has accrued to Colombia or Panama. We have seen the same experience in Egypt with the Suez canal.

The protracted bloody struggle sustained by Mexico in order to shake off colonial principles and church rule, and to follow the pathway of progress, precluded during thirty years any effort in the direction of interoceanic communication. However, as soon as there was a respite in the civil struggle, the project was taken up again. On March 1, 1842, General Don Antonio Lopez de Santa Anna, at that time dictator of Mexico, granted a charter to Don José Garay, to open communication across the isthmus of Tehuantepec, by water as far as practicable and for the rest of the way by rail, beginning the work by a survey of the land and location of the road—which was to be done within eight months from the date of the contract—and fixing a time for the completion of the work. Señor Garay entrusted that work to Señor Don Gaetano Moro, an able Italian engineer, who accomplished it very satisfactorily, this being the first scientific survey of the projected road after Mexico achieved its independence.

The decree of March 1, 1842, which was the first concession made to Garay, provided for the opening of a road through Tehuantepec and entrusted the building of the same to Don José de Garay. That concession was enlarged by a new grant of land, by a decree of February 9, 1843. Another decree provided for the establishment of a prison in Tehuantepec with 300 convicts to help in the construction of the road, and still another extended the term specified for the beginning of the work. The time expired on

June 30, 1845, and that ended the Garay grant, for non-compliance with its provisions, although he applied to congress for a new extension of the term of the concession, which was granted by the house of representatives in December, 1845, but never was voted upon in the senate. But on November 5, 1846, the president of Mexico, acting under extraordinary powers, issued a decree ratifying all previous concessions made to Garay, enlarged the land-grants, and extended for two years from the date of that decree the term for beginning the work.

Notwithstanding all these privileges granted to Garay by the Mexican government, he could not even begin the work under the time fixed, because he could not command the capital necessary. During the progress of our war with the United States, in 1846-47, Señor Garay sold his charter to Messrs. Manning and Mackintosh and John Schneider of London, who, after the war, sold it to a New York company headed by Mr. Peter A. Hargous, but the Mexican government contended that Garay's charter had been forfeited for want of compliance with its conditions, and that all transfers made by him were null and void, not only on that account, but also because the permission of the government to transfer the grant had not been obtained. At the end of that war, by the treaty of Guadalupe Hidalgo of February 2, 1848, by which the United States acquired an extensive coast on the Pacific ocean, it became necessary for that country to look for a short way of communication between its Atlantic and Pacific coasts. Naturally it was thought that Tehuantepec offered the greatest advantages, although the United States, having foreseen that need, negotiated a treaty with New Granada, signed in Bogota December 12, 1846, in which passage across the isthmus of Panama was guaranteed to them, with other very liberal concessions. For the same reason the United States made great efforts to obtain from the Mexican government a charter similar to the one they had obtained from New Granada, which they asked during the progress of the negotiations preceding the treaty of peace; but the Mexican government, fearing, not without reason, a repetition in Tehuantepec of what had just happened in Texas, did not deem it advisable to make the concession for building the road to a company of citizens of the United States, and answered that, as a grant was already in the hands of the Garay company, the government had no right to dispose of the same.

As a consequence of this answer given by the Mexican plenipotentiaries who signed the treaty of Guadalupe Hidalgo, the parties interested in building the Tehuantepec railroad obtained the cession of the charter from Messrs. Manning and Mackintosh, who, in their turn, considering themselves the successors of Mr. Garay, sold their charter to a United States company and asked a guarantee of the United States government to develop said concession.

This government requested Mexico to make a treaty for that purpose, and, notwithstanding the reluctance of Mexico on this point, at the request of the United States government the Mexican plenipotentiary signed on June 23, 1850, a treaty with Mr. Robert P. Letcher, the minister from this country at the city of Mexico, by which both governments guaranteed the neutrality of the isthmus, under certain conditions that were considered sufficient to assure the autonomy and independence of Mexico, but that treaty was rejected by the United States senate, and the United States government asked for a modification of the same, which request resulted in another treaty, signed January 25, 1851, and rejected in its turn by the Mexican senate.

The principal cause of the rejection of those treaties was that the government of the United States contended that they guaranteed the Garay charter, which had fallen into the hands of United States citizens, while the Mexican government, far from accepting that view of the case, declared the said concession forfeited, and considered that it would be extremely dangerous for Mexican interests should that road be built by citizens of the United States.

The feeling of distrust against the United States which prevailed in Mexico immediately after the war of 1846 and 1847 was strengthened by reason of some filibustering invasions of the border states of Mexico, which occurred about that time, and which the United States government could not prevent. As the people of Mexico did not understand well the laws of the United States, the extent of personal guarantees enjoyed here, and the feeble action of the federal government in the States, it was not believed that this government had no power to prevent such invasions.

It is very satisfactory to notice the change in the relations between Mexico and the United States since 1851. The Mexican government at that period not only refused to grant a concession to citizens of the United States, but considered it dangerous for engineers from that country to finish the survey which they were making of the isthmus of Tehuantepec.

Now, however, almost all the railway concessions given by the Mexican government—and their number is considerable—have been made to citizens of the United States. The principal railways in Mexico, with only two exceptions—those running from Vera Cruz to the city of Mexico—have been built by companies organized in the United States. The idea of permitting the passage of troops from the United States into Mexican territory in pursuit of hostile Indians was then considered as inacceptable; indeed, according to the statement of Mr. Robert P. Letcher, the American minister, made to Señor Don Fernando Ramirez, the then minister of foreign affairs of the Mexican government, United States soldiers were then more objectionable in Mexico than hostile Indians. Since then, however, that permission has been freely granted and with satisfactory results. This shows that the situation of distrust and even unfriendliness resulting from the war of 1846–47 has given place now to one of mutual friendship and cordiality, as a consequence principally of the change in the political tendencies of the parties in the United States which do not seek now, since the abolition of slavery, to annex Mexican territory.

In view of the determination of the Mexican government not to recognize the charter for the building of the road which had come to the hands of a company of citizens of the United States, the parties interested in the transit applied to the government of New Granada, and received from the latter a liberal concession. The construction of the Panama road was begun on April 18, 1850, and ended on January 20, 1855. The building of that road made unnecessary, for the time being, the construction of the Tehuantepec road, and this circumstance, in my opinion, more than anything else, has been in the way of the building of the Tehuantepec road.

The agitation produced by the treaties negotiated with the United States about Tehuantepec and the efforts of the parties who had succeeded in the Garay grant to have it recognized by Mexico gave rise to a long and bitter discussion, with the result that the Mexican congress, on May 22, 1851, declared forfeited the charter granted to Don José Garay on the ground that he had not fulfilled its conditions.

But the Mexican congress, awake to the necessity of opening a means of communication, passed a decree on May 14, 1852, requesting the executive to promote the organization of a company to undertake the building of the Tehuantepec road, on the basis therein set forth. Pursuant to that decree the executive branch of

the government published, on July 29 of the same year, a notice inviting proposals for the building of that road, and, after considering those that were presented, a contract was signed with Mr. A. G. Slow and others, by which it was agreed that a year after the signing of the contract a plank road should be commenced to be ended three years afterwards, and then succeeded by a railroad, which should be completed within the following four years.

The same decree of May 14, 1852, provided that negotiations with friendly powers would be opened, with a view to arranging treaties which should recognize the neutrality of the passage through the isthmus, in case of war; and by virtue of that provision a treaty was signed at the city of Mexico on March 21, 1853, between the Mexican plenipotentiaries and the United States minister, in which permission was granted to the United States government to guarantee with armed force the neutrality of the isthmus, when requested by the Mexican government, and granting it besides the free passage of their troops from one coast to the other. In the treaty especial guarantees were joined to the contract with Mr. A. G. Slow and company; but, for the reasons already pointed out, that treaty was rejected by the Mexican congress, and in consequence of this fact, and on account of the Panama road having been commenced, the Slow company could not fulfil their contract.

On September 7, 1857, the administration of General Comonfort, acting under extraordinary powers, granted to the Louisiana Tehuantepec Company, organized in New Orleans on July 30 preceding, a charter for the construction of the Tehuantepec route, making use of the Coatzacoalcos river as far as it could be made navigable, the rest of the distance to be covered by rail. Work was to begin within eighteen months after the date of the decree, the railway was to be built at the rate of ten Mexican leagues (about twenty-six miles) per year, and a carriage-road was to be opened at the beginning. The latter was opened, in part, and in this way a stage-coach line was established in connection with ships running between New Orleans and Minatitlan and between Ventosa and San Francisco, except that passengers had to travel a short distance by horseback. The company agreed to pay Francisco P. Falconet $600,000 and interest, which was deposited by the Slow company with the Mexican government in accordance with Article IV of their contract, and therefore the Louisiana company was in fact the successor of the Slow company.

After several additional concessions had been made, a decree

issued by President Juarez on October 15, 1866, declared the forfeiture of the concession made to the Louisiana Tehuantepec Company, owing to the non-fulfillment of its obligations, and granted the same to the Isthmus of Tehuantepec Company, which failed also to fulfill its obligations, after which the charter was forfeited by a decree of August 16, 1867.

The war of reform on one hand, which lasted from 1857 to 1866, and the French intervention on the other, from 1861 to 1867, as well as the bad financial situation of the world, had prevented the work, notwithstanding the several concessions successively made by the Mexican government; but it was believed that with peace restored to Mexico, the principal drawbacks had disappeared, and, on October 6, 1867, a concession was granted—also by virtue of extraordinary powers vested by congress in the president—to Emile La Sere, a native of New Orleans, or to a company that he might organize. This concession was modified by an act of the Mexican congress under date of January 2, 1869, considerably amplifying the privileges granted to Mr. La Sere or his company, and extending the terms for the completion of the work.

Another act of the Mexican congress, under date of December 20, 1870, renewed and extended the terms of that concession, though the name of Emile La Sere was then omitted. The act passed by the Mexican congress on May 22, 1872, renewed the concessions of 1869 and 1870, and provided that the time for building the road should be counted from January 2, 1872.

The Mexican congress, by an act of June 2, 1879, gave a charter to Edward Learned, a citizen of the United States, or the company that he might organize, to build the Tehuantepec road within three years and four months from the date of the charter, and offered a subsidy of $7500 for each kilometer of road built by the company and actual land opened. Mr. Learned organized a company in New York which held the grant for several years and built in a provisional way a few miles of road from the mouth of the Coatzacoalcos river towards the south.

After long experience in ineffectual efforts had shown that it was not possible to secure this road even under the liberal concessions made by the Mexican government, it was suggested that the government should undertake the work on its own account. Congress, therefore, authorized the executive, on May 30, 1882, on account of the State, to build the Tehuantepec railway or to contract for its construction with a company.

By virtue of this authorization the Mexican government signed, on October 15, 1888, a contract for the construction of the road with Edward McMurdo, the representative of Salvador Malo, authorizing a loan of £2,700,000 for the expenses of the same, which was raised at London, Berlin, and Amsterdam by the sale of 5-per-cent. bonds at about 70 per cent. This contract was approved by an act of the Mexican congress of December 19, 1888, and was modified by another contract signed on October 15, 1889, also subsequently approved by congress.

To carry out this purpose it was necessary first to terminate the contract still pending with the Learned company. This company agreed to give up the contract, receiving a compensation for expense and damages of $1,500,000 in United States gold, which I paid in New York on behalf of the Mexican government.

As the proceeds of the loan of £2,700,000 were not sufficient to finish the road, part of another loan of £3,000,000, recently contracted at the city of Mexico, has been applied to that work. On December 6, 1893, a contract was signed at that city for the construction of the fifty-nine kilometers of road unbuilt, and it is provided in the same that the line shall be finished on September 6 of this year, with an additional expense of over $1,000,000.

This account would not be complete if I failed to mention that the distinguished engineer, James B. Eads, conceived a project for building a railway capable of transporting ships from one ocean to the other, across the isthmus of Tehuantepec; and for that purpose he made on April 26, 1881, a contract with the Mexican government, which was ratified by the act of the federal congress on May 28 of that year, and that charter was modified and amplified by another contract signed at the city of Mexico with the representative of Captain Eads on May 2, 1885, which was also approved with certain alterations by the Mexican congress on December 15, 1885. In the first of those contracts it was stipulated that the work would be finished within twelve years from May 6, 1881, and that term was extended two years by the second contract. The Mexican government promised to pay the company as a guarantee $18,750,000 at the rate of $1,250,000 each year, to be eventually refunded if the profits of the railway should exceed $3,750,000 a year, and in that case the sixth of that excess would be applied to the payment of the subsidy. The company was authorized to build a canal from Laguna Superior to the Pacific ocean, and it was further offered 168 square kilometers of land for every

foot in depth of said canal. It was also offered 4200 square kilometers of land if it should deepen the Coatzacoalcos 25 feet.

Unfortunately, the extraordinary character of the project and the other difficulties to which I have alluded have not permitted the construction of this great work, but as a similar road is on the point of being completed on the isthmus of Chignecto, which connects the peninsula of Nova Scotia with the mainland in Canada, and will show the practicability of the work, it is likely that this fact will pave the way to the construction of a similar railway across the isthmus of Tehuantepec. The Chignecto ship-railway, which will connect the navigation of the Bay of Fundy with the Gulf Saint Lawrence, is 17 miles in length and capable of carrying ships weighing 2000 tons. About three-fourths have already been built.

All the grants above mentioned have led to the making of surveys of Tehuantepec. Besides the one made by Señor Moro, the United States Company in 1850 sent Major J. G. Barnard, U. S. A., as chief of engineers, to make a survey of the Tehuantepec isthmus, and although the condition of affairs which I have tried to sketch compelled the Mexican government to order the suspension of the survey, it had already been finished when Major Barnard was notified to leave the work, and the results were subsequently published.

During the administration of General Grant another and more complete and important survey was made, he wishing to ascertain which of the three isthmuses was the most convenient for the construction of a means of interoceanic communication. He sent a commission of able engineers, which decided in favor of the way through Nicaragua. The concession made to Captain James B. Eads caused a more elaborate survey to be made, not only of the railway, but also of the terminal points.

The Mexican government sent a delegate to present the advantages of Tehuantepec at the International Congress on American Interoceanic Communications convened in 1879, at Paris, at the suggestion of M. Ferdinand de Lesseps, but he could hardly be heard for the reason that the preference was given to the Panama route almost before the meeting of the conference, though without taking into consideration the difficulties to be encountered. As M. de Lesseps was the promoter of the congress, it was composed largely of his friends, and he obtained a vote in favor of Panama of 74 members, while only 14 voted against him and 7 refrained from

voting. The Mexican delegate voted against Panama. Those who did not vote represented that the matter had not been sufficiently discussed and that a majority of the members were not competent to decide the difficult technical questions, and among these were Admiral Ammen and Señor Menocal, delegates from the United States; Señor Don Manuel M. de Peralta, delegate from Costa Rica, and now minister from that country to Washington, and Señor Ordonez, delegate from Colombia. M. La Valley, the distinguished French engineer who built the Suez canal, and who was a friend of M. de Lesseps, did not vote for Panama.

After so many efforts resulting in failure, the Tehuantepec road is now practically completed, and Mexico offers the result of all this work of many years to the commercial interests of the world.

The comparative advantages of the Tehuantepec interoceanic route over the Panama route, in reference to geographical and commercial features, are great. Any map showing the two routes will prove in a general way the geographical advantages of the Tehuantepec route in reference to the coastwise commerce of the United States, and, in a measure, its advantages in relation to the business of western Europe. Admiral Schufeldt, U. S. N., in an official report made in 1871, thus forcibly expressed the commercial advantages of Tehuantepec: "Each isthmus rises into importance as it lies nearer to the center of American (United States) commercial interests." Other things being equal, the route which has the greatest advantages will lie nearest to what may be considered the *axial line of the world's commerce*, which may be drawn on the globe between Hongkong and Yokohama on the Asiatic coast across the Pacific ocean, through San Francisco, across the United States to New York, and across the Atlantic to Liverpool or Havre. Tehuantepec, of all the interoceanic routes, lies nearest to this "axial line." In a direct line the distance is 1200 miles between Tehuantepec and Panama, or about as far as from New York to New Orleans.

Examination of a globe will show that the shortest sail or steamer route from eastern Asia to any point on the Pacific coast of the American isthmus passes in close proximity to the shore line of Tehuantepec; in fact, the shortest great circle from Panama to Hongkong will pass through Tehuantepec, east of San Francisco, and nearly up to the Aleutian islands. Even the shortest route from Panama to the Sandwich islands will pass close to Tehuantepec. It will at once be apparent, therefore, that it will require almost a doubling of the above-mentioned distance to cross

the isthmus at Panama, particularly for all traffic of the Pacific ocean seeking gulf ports. In a lesser degree the distance by way of Panama to all Atlantic ports of the United States and eastern Europe will be largely increased over the Tehuantepec distance.

DISTANCE IN STATUTE MILES BETWEEN PORTS.

[Compiled at the Hydrographic Office, Bureau of Navigation, United States Navy Department.]

Terminal Points.	Via Tehuantepec Railroad.	Via Nicaragua Canal.	Via Panama Railroad.
New York to San Francisco	4925	5651	6107
New York to Puget Sound	3647	6524	6855
New York to Sitka	6347	7113	7555
New York to Bering Strait	7788	8534	9101
New York to Acapulco	2722	3507	3988
New York to Mazatlan	3476	4232	4675
New York to Hongkong	11597	12313	12645
New York to Yokohama	9984	10626	11211
New York to Melbourne	11068	11357	11471
New York to Auckland	9345	9745	9813
New York to Honolulu	6566	7390	7705
New York to Callao	4661	4312	3873
New York to Guayaquil	4141	3774	3303
New York to Valparaiso	6370	5774	5337
New Orleans to San Francisco	3561	4776	5415
New Orleans to Acapulco	1454	2631	3296
New Orleans to Mazatlan	2027	3357	3983
New Orleans to Callao	3393	3436	3181
New Orleans to Valparaiso	5040	4899	4644
Liverpool to San Francisco	8274	8783	9071
Liverpool to Acapulco	1076	6639	6952
Liverpool to Mazatlan	6714	7364	7640
Liverpool to Auckland	12584	12877	12777
Liverpool to Guayaquil	7379	6848	6267
Liverpool to Callao	7899	7444	6837
Liverpool to Valparaiso	9356	8906	8301
Liverpool to Honolulu	9805	10522	10670
Liverpool to Yokohama	13223	13758	14175
Liverpool to Melbourne	14113	14499	14435

If a comparison is made between Tehuantepec on sixteen of the main routes of commerce between the east and the west, the total saving by Tehuantepec is over 125,000 miles. It will also be seen that the question of comparative distance also affects to an important degree the entire interior of the United States, particularly the Mississippi valley. It is only a little over 810 miles from the mouth of the Mississippi river to the eastern terminal of the Tehuantepec railroad. The total distance by rail and water from Chicago to the Pacific ocean via Tehuantepec is only 1875 miles.

The *nautical* conditions for sailing vessels are much more favor-

able at Tehuantepec than at Panama. Navigators always avoid, if possible, the region of calms on both sides of the Panama isthmus. These calms extend well into the Pacific ocean at Panama. Lieutenant Maury and Captain Bent, both acknowledged nautical experts, are my authority for this statement.

This advantage may be considered by some as of little importance on account of what is supposed to be the rapid substitution of steam for sail, but, as far as the United States is concerned, the advantages of good nautical conditions are important, and will be for many years, as their sailing tonnage greatly predominates over steam. From the above statement it is apparent that an inter-oceanic route established at Tehuantepec will connect, at the best possible location, the eastern and western coasts of the United States and Mexico, and will develop a coastwise business of great magnitude and of vast importance to these two countries if controlled and managed by United States interests.

The *climatic* conditions are more favorable at Tehuantepec. The northeast trade-winds from the United States cross the Gulf of Mexico, making the climate of Tehuantepec healthful. I was born and for many years lived at the city of Oaxaca, the capital of the State to which Tehuantepec belongs, and have been in Tehuantepec, and I can assert by personal knowledge that it has a healthy climate, taking in consideration its latitude and altitude.

General Porfino Diaz, who has been the president of Mexico since 1877, with an interval of four years, is a native of the city of Oaxaca, and he spent two of the most eventful years of his life—1858 and 1859—in Tehuantepec as civil and military governor of that district, and has had great interest in building that road. To his exertion is due the condition in which that work is now nearing completion. It is to be hoped that its results will be beneficial to the commerce of the world, and that will be a compensation for the many efforts, disappointments, and great expense made, suffered, and borne by Mexico in carrying out this great work of public improvement.

After I had written my first draft of this article, fearing that I might have omitted important facts or committed serious inaccuracies, I sent to the proper department of the Mexican government a copy of the same, for its revision and correction. The editor of the Magazine, however, having made arrangements for the publication of the paper at this time, and desiring not to disappoint or inconvenience him, I have consented to let the article go before the public before receiving the data which without doubt has been sent from Mexico. If it should seem necessary later, I may write a short statement pointing out any inaccuracies in this article, for publication in the next number of the Magazine. M. R.

ELECTRICITY

Conducted by Franklin L. Pope.

AS long ago as 1880 the late Dr. Charles W. Siemens, in a paper read before the Society of Telegraph Engineers, gave an interesting account of the results of a series of experiments in electro-horticulture, made by him in his conservatories near Tunbridge Wells, England. He found that the exposure of growing plants to the rays of the arc-light had a decided effect in the promotion of their growth, and in the development of chlorophyll in their leaves. It appears also to have been pretty conclusively established by his results that the idea formerly prevalent that plants require a period of rest during a part of each twenty-four hours has no foundation in fact, as the plants experimented upon by Dr. Siemens, although exposed to full sunlight during the day and to the rays of the arc-light during the night, made increased and vigorous progress in consequence. The electric rays, moreover, proved peculiarly efficacious in accelerating the development of flowers and fruit; the flowers were remarkable for the unusual vividness of their coloring, and the fruit both for its beautiful bloom and its fine aroma. Further experiments in this general direction, though upon an entirely different plan, have been made during the past year at the Hatch experiment-station of the Massachusetts Agricultural College. Small plots of ground were planted with common garden vegetables, and a constant current from a voltaic battery was made to pass directly through the mass of earth in which the roots of the plants were embedded. The foliage of the parsnips which had been thus subjected to the action of the electric current showed a growth far more vigorous and rapid than those occupying a non-electrified plot, although planted at the same time, and when harvested seemed to be nearly twice as large; the roots also were much heavier, and, as a whole, the plants showed a marked difference in favor of electric culture. A peculiar effect which was noted, for which no satisfactory explanation has been suggested, was that the plants nearest the negative electrode grew much faster, and ultimately became much larger than those at a greater distance from it. Upon carefully weighing the products of the respective plots it was found that in the electric plot nearly a pound of tops had been produced for every pound of roots, while in the non-electric plot there were 1.43 pounds of roots for each pound of tops. In the total weight of roots and tops the difference in favor of electric culture was found to be as 34 pounds 10 ounces to 24 pounds 3 ounces. Other kinds of vegetables with which similar experiments were made gave results very nearly proportional. If the transmission of electric currents through the earth has an important influence on the growth of plants, as these experiments would seem to demonstrate, the market gardens in the suburban districts of Boston, Brooklyn, and other cities gridironed by electric railways, surely ought to be in an exceptionally flourishing condition.

THE most serious problem that to-day confronts the managers of the telephone systems of the United States is the continual expansion of the service; not so much that due to the augmented number of exchange subscribers, as to the increased use by each individual subscriber of the facilities offered. Ten years ago, for example, the average number of calls and connections made by each subscriber in the larger cities was about six, but at the present time the average has already increased to twelve. It is a fact not generally appre-

ciated that the cost of central-station apparatus and equipment, as well as that of operating the exchanges, increases almost in the ratio of the square of the number of subscribers. This is the principal reason why the telephone companies are compelled to charge their customers so much higher rates in the larger than in the smaller exchanges. A moment's reflection will show that the true criterion of the cost of telephone service to the subscribers is not the yearly rate, but the average cost to each user per conversation or connection made. It certainly does seem inequitable that a person who uses his telephone perhaps not more than three or four times per week should be charged the same yearly rental as one who keeps it in constant use all day and every day, but the fact must not be lost sight of that it is necessary to provide facilities for the most extensive service for each subscriber, whether availed of or not, and that it costs a great deal of money to effect this result. The true solution of this perplexing problem will doubtless be found, in the future, in some plan by which each subscriber will be charged a flat yearly rate sufficient to cover interest on first cost and ordinary cost of maintenance of plant, together with general charges of administration, and in addition to this will be required to pay a fixed charge per connection made or message transmitted. By this plan the proportion between gross receipts and operating expenses will be maintained, and each subscriber will in effect pay for what he gets. This system or something nearly resembling it has been in vogue in some cities, notably Buffalo, for many years, and appears to have, on the whole, given good satisfaction. Unless some such plan as this is adopted it appears to us that the time must come, and that before many years, when even the apparently excessive rate now charged in New York city will be found to be insufficient to cover the actual cost of performing the service required.

In anticipation of the expiration of the patents on the Bell telephone-receiver, many enterprising manufacturers in various parts of the country had made extensive preparations to offer these instruments for sale in the open market at various prices, ranging from $3 upward. It could have scarcely have been expected that these could have received with unmixed gratification the announcement made by the Bell telephone companies, within a day or two after the date of the expiration of the patents, that instruments of their well-known standard make and finish would be sold freely to all purchasers at the almost nominal price of $1.25 each. The result of this move undoubtedly will be a great popularization of the telephone for purposes of private intercommunication, inasmuch as a complete outfit of telephones, signal-bells, and a connecting line say half a mile in length need not cost, at present prices, more than $30 or so, while the cost of maintenance, other than that of keeping the line in repair, will be practically nothing. The ultimate effect of thus accustoming everybody and his wife and children to the use of the telephone cannot but be to enormously increase the demand for exchange facilities, especially in the provincial cities and towns. The telephone is certainly destined to become a most invaluable convenience to the rural householder throughout the land.

The New York capitalists who have invested more than $3,000,000 in the stupendous power-plant now under construction at Niagara Falls have exhibited very little anxiety to exploit their plans in the public journals, and, as an inevitable consequence, a vast amount of misinformation on the subject has found its way into print. The general plan of the work was accurately described by Dr. Coleman Sellers in an early number of this Magazine, but at that time many of the more important details were yet undetermined. It was ultimately decided that of the 100,000 horse-power provided by the existing tunnel, when utilized to its full capacity, 50,000 should be allotted to manufactories situated in the immediate vicinity, most of which are expected to be of a character requiring power in large blocks—such as paper- and pulp-mills, and electrical smelting-works—

while the remaining 50,000 should be converted into electrical energy and transmitted by wire to points where it could be advantageously utilized in smaller units. The three dynamos now building at Pittsburgh, which are expected to be in place and at work early in the coming summer, are to have a capacity of 15,000 electrical horse-power, most of which will probably be sent to Buffalo, as a power-distributing company which has been formed in that city is said to have contracted for a minimum supply of 10,000 horse-power. Other companies for the same purpose have been formed in a number of the principal cities and towns of central and western New York. The price at which the electric energy will be furnished has not been absolutely fixed, but will probably be something like $12 to $15 per horse-power per year, for the twenty-four hours. Even in the present state of the art it is not improbable that the power from Niagara can be supplied at a rate permitting commercial competition with coal, at any point within a radius of one hundred miles.

IT is a fact which is, or at least ought to be, well known to engineers, that the term "horse-power," as signifying a certain rate of doing work, is absolutely meaningless, except as an arbitrary conventional term which has been adopted by common consent. The tradition is that James Watt, by experiments with a good average Clydesdale draft-horse, found that such an animal could do work, day in and day out, at a rate approximating 22,000 pounds raised one foot in one minute, and then, distrusting the results of his own experiments, he arbitrarily raised the value of his horse-power unit to 33,000 foot-pounds. Of late years the distribution of power is obviously falling largely into the domain of electricity, and hence is more and more coming to be commonly spoken of in terms of the accepted electrical units, which, as is well known, are based on the decimal or metric system. Of the electrical unit of rate of work, the watt, 746 go to the horse-power, but any considerable amount of power is more conveniently measured in kilowatts, of 1000 watts each, ordinarily abbreviated as "k. w." Now why should not mechanical as well as electrical engineers agree to drop, once for all, the meaningless term "horse-power," as a relic of the dark ages, and henceforth determine to use the far more convenient as well as more scientifice unit the kilowatt? Fortunately, the relation of the old and new units happens to be such that they may be converted into each other, with sufficient accuracy for most purposes, by a very simple mental calculation, the horse-power being three-quarters, or, in exact terms, 74.6 per cent. of the kilowatt. The time is prophesied when the horse, except as a zoological museum curiosity, will be unknown, but the horse-power has already become, at least among electrical engineers, a useless anachronism.

IT is stated in foreign journals that the conduit electric-railway system which has been at work for some years in Budapest has proved so satisfactory in its practical operation that it has now been determined to replace all the horse lines in the city by electric lines operated in the same way. The total length of the extensions proposed will be over forty miles.

ONE of the manifold possible uses of the telephone, which for some reason has failed hitherto to receive anything like the attention which its importance would seem to warrant, is that of interior service for offices, stores, manufactories, and the like. Within a year or two, however, some very ingenious and effective systems of this character have been devised, which, so far as they have been practically introduced, have given great satisfaction. It seems not in the least unlikely, now that the patents on the essential portion of the apparatus have expired, that the number of instruments required for what may be termed interior intercommunication may, within two or three years, exceed the aggregate number in use in the regular exchanges.

THE tendency of the constructors of electric central stations in the principal cities is towards larger and larger units. In the Elm-street station of the Edison

Illuminating Co. of New York a quadruple-expansion engine of 3000 horse-power has recently been set up, which is coupled directly to a pair of dynamos each of 800 kilowatts, or 1350 horse-power capacity. The steam-piping of this plant is constructed to stand a pressure of 225 pounds per square inch.

THE discussion of the relative merits of the cable and electric systems of propulsion for street-railway service is still continued in a desultory way in the technical journals, although the subject would seem by this time to be pretty well threshed out. It now appears to be quite generally admitted that in all cases where the overhead trolley system is permissible, not only the cost of construction, but the cost of maintenance and of operation is much lower for the electric than for the cable system, and this is equally true whether the traffic be heavy or light. The stock objections which are reiterated to the trolley system; the unsightliness of the overhead structure; the interference with the fire-extinguishing service, the increase in insurance rates, are, after all has been said, of almost insignificant importance compared with the great good which it confers upon a great number. It is undoubtedly true that in many localities there is a decided need of the imposition of more restriction upon the reckless speed at which street-cars are sometimes run, and that in thickly populated districts the substitution of a conduit system for the overhead construction should be brought about as soon as practicable. We do not, however, believe that it is true, as stated by a prominent transportation journal, that the conduit system "has purposely been kept in the stage of experiment" by the electrical companies. It is probable that the cost of construction of a thoroughly good conduit system, should one be developed, will be little if any less than that of a cable system, but the former may reasonably be expected to make much the best showing of the two in respect to cost of maintenance and operation. We fully believe, however, that means will yet be found to cut down the consumption of power per car, to at least one-half of what it now is with the best electric systems.

THE annual report of the railroad commissioners of Massachusetts for the year ending June 30, 1893, shows an increase of 214 miles in the aggregate length of street-railways operated by electricity within that commonwealth. The judicious and timely warning of the commisioners against the prevalent craze for gridironing the earth with electric railways, which has been in some degree postponed but by no means permanently dissipated by the financial stringency of the past year, deserves more attention from investors than it is at all likely to receive. Referring to the idea which seems to have taken possession of many minds, that an electric-railway system is necessarily a bonanza of inexhaustible wealth, the commissioners say: "It can and should be said, without hesitation or qualification, that the electric system has not shown or indicated any such margin of profit as to justify the expectation of more than moderate and ordinary returns on money legitimately invested in it. . . . . The absolute cost and expensiveness of the system under the most conservative, able, and honest management, are sufficient to task its earning capacity to the full limit. There is no margin for fictitious or inflated capitalization. It presents no safe or inviting field for speculative enterprise or manipulation, unless it be to the unscrupulous operators of an inside ring who are willing to practice on the credulity of a misinformed public." The commissioners indeed even go so far as to say: "We must conclude, taking everything into the account, that there has thus far been no demonstration of the superior net-earning capacity of the electric as compared with the horse system, but rather the reverse." From their point of view, which is of course based on the detailed returns of receipts and expenditures filed in their office by the various railway companies of the commonwealth, the commissioners are doubtless justified in their conclusion. But, on the other hand, it must not be forgotten that the electric-

railway system is even yet largely in an experimental stage. For example, the constant improvements which have been made in the details of motor construction have been such as to render it necessary to replace the earlier types by wholesale, even when but slightly deteriorated by use, simply because the new designs were so much more economical in operation than the old that the use of the latter could no longer be afforded at any price. Then, too, the art of operating electric railways with the utmost attainable economy, though well enough understood by many experts, is one that is learned but slowly by many of the men who have the actual management and handling of the mechanism. The introduction of these minor economies is a process that necessarily takes time, even under the most intelligent and energetic management. We hazard little in making the prediction that within ten years electric railways will be operated at one-half the present expenditure of power and at one-half the present cost of maintenance. But we agree most emphatically with the commissioners in their evident opinion that there is no miraculous power in electricity which will save an electric railway from the too-familiar fate of the steam- or horse-railway, which is confronted with the adverse conditions of injudicious location, inefficient management, and over-capitalization.

THE telephone system of New York city now comprises no less than eight independent exchanges, all equipped with metallic-circuit multiple switch-boards, and furnishing in the aggregate accommodation for 15,000 subscribers. The present number of subscribers in connection with all the exchanges is about 9600. There are 800 private-line stations, and no less than 30,000 miles of underground wire. The average number of conversations per day in the city is between 80,000 and 90,000. Each subscriber uses his telephone on an average sixteen times per day, although in some instances it is used as often as 100 to 200 times per day. About 400 young women are employed as operators in the central offices, 250 of whom are usually on duty at the same time. Each of these operators makes an average of nearly 400 switchboard connections per day. The aggregate working force required to maintain the Metropolitan telephone service comprises about 1000 employés, or about one to every nine subscribers. As the yearly rate paid for the rental of each telephone is $240, it appears that the average cost to the subscriber per conversation is only 4.9 cents. The cost of transmitting the same amount of information by telegraph, at the regular Western Union city rate of about one cent per word, could hardly cost less than ten times as much. The improvements constantly being made in the details of the service, while they do not, and from the nature of things cannot, lessen the annual cost per subscriber, do materially increase the facility of use, and in that way constantly diminish the cost per message, which, as we have elsewhere pointed out, is the only true criterion of the actual cost of telephone facilities.

IT is now announced in the newspapers that the parties who were in charge of the recent experiments illustrating the utilization of electricity for the propulsion of boats upon the Erie canal, design to fit up a boat with electric motors and propellers of the most approved design, which is to be propelled by storage-batteries, and equipped with all kinds of electrical labor-saving devices, and exhibited along the line of the canal as a sort of object-lesson in the uses of electricity. We would suggest that the most appropriate source of energy for charging these storage batteries would be wind, which can usually be obtained at reasonable rates upon the breezy hill tops of the Empire State. Still, we cannot resist the conviction that what is really needed to permanently improve the navigation of the Erie canal is more water, and less rather than more wind.

THE statement is made, apparently by authority, that the trade of one of the principal electrical companies of the United States, for repairs of electrical machinery alone, amounts to nearly $4,000,000 per annum. This allegation, if

true, indicates a state of facts, which would seem to call loudly for immediate reform.

AN electric-lighting plant driven by wind-power has for some time been in successful operation in Jersey City. The wind-wheel is 18 feet in diameter, and self-regulating. With a wind-speed of twenty miles per hour it is said to give about 3 horse-power, and the generating machinery comes into action only when this speed has been reached. A small dynamo of a capacity of 35 volts and 35 amperes is employed, which is belted to the wind-wheel, through an intermediate bevel-gear. A storage-battery charged by the dynamo, and fitted with an automatic cut-out, provides current for twenty-four incandescent lamps, distributed about a workshop.

RECENT experiments have been made which are claimed to have demonstrated that rapidly-alternating electric currents, of which telephonic currents are merely a particular case, are much more perfectly transmitted through a conductor composed of two metals of different specific electrical conductivity, than upon one consisting of a single homogeneous metal, and this, in spite of the fact that the conductivity of the latter, for steady currents, may be much the higher of the two. It is also asserted that a much lower insulation resistance is needed to confine the current to the bimetallic than to the monometallic conductor. No satisfactory explanation of this alleged phenomenon has been vouchsafed, even by the discoverer, but it is safe to say that, in the present advanced condition of electrical science, it will not be long before a matter of so much practical importance—if true—will be sifted to the bottom, and the results published to a somewhat skeptical world.

THE preposterous schemes of a continuous street-railway from New York to Philadelphia and another from Washington to Baltimore, to be operated on the overhead trolley system, are just now receiving a good deal of attention in the columns of the local newspapers. It was once pertinently observed by a picturesque humorist, whose memory still haunts the purlieus of Wall street—apropos of a certain railway consolidation in contemplation at the time—that "you can't make a good omelette out of a lot of bad eggs." No more can a profitable through railway line be made by the combination—end to end—of a series of local lines having individually neither potency nor promise of ever meeting even their operating expenses. It is astonishing that people can be found to put money into such schemes, merely because they are labeled "electrical." We would sooner—much sooner—invest in a line of horse-cars over the same routes, because the permanent investment would be less.

IT is stated that ground has been acquired on the water-front in Baltimore for the erection of a mammoth electrical central station for the generation and distribution of light, heat, and power, which is designed to have an aggregate capacity of 12,000 horse-power.

A SUCCESSFUL application of the storage-battery for telegraphic service has been made in the Baltimore office of the Postal Telegraph Cable Co. It has been found that 500 storage-cells are ample to do the work heretofore requiring 2500 large gravity-cells. The cells are charged from the electric-lighting street service, by means of a small motor-generator of half a horse-power. The battery is divided into twelve sections which are charged in rotation by the motor-generator. The cost of maintenance of the gravity-cell heretofore used is given as $1.10 per annum, which cannot be far from the truth. An equivalent quantity of electricity, capable of doing the same work, when purchased at the ordinary rate from the electric-lighting company, costs about 9 cents. It is estimated that the positive plates of the storage-battery, under the service required, will not need renewal oftener than once in two or three years.

ARCHITECTURE

Conducted by Barr Ferree.

THE Frenchites have at last taken official root upon the free soil of America. And it must certainly be admitted that those architectural gentlemen who call themselves Beaux-Arts men show a most commendable industry and earnestness. Their efforts to fasten the academic spirit of contemporary French architecture upon the building geniuses of America have received fresh strength from the founding of the "Beaux-Arts Society of Architects" in the city of New York, and its incorporation in the State of the same name. A duly incorporated body is certainly formidable, and we lose no time in saluting the present organization, originally started as a sort of alumni society on a most liberal scale, for it appears that all who have been "received as pupils at the École des Beaux-Arts of Paris in the department of architecture, and are pursuing the profession of architecture, shall be eligible as members." It would seem that more than the simple passing of the entrance examinations at the Paris school should have been required for membership in this society, for it is reasonable to suppose that it would be easier to "cultivate and perpetuate the associations and principles of the École des Beaux-Arts" by insisting on a certain amount of work at the School. This, however, is entirely the business of the society, and it may be accounted sufficiently responsible for its own notions to pass on the individual merits of its own members. It is impossible to deny that the possibilities for harm and for good in such an organization are very great. An active and agressive campaign in which "France for the Frenchites!" shall be the battle-cry could most effectually put a stop to all hope for American architecture, and reduce our own work to the dullness of that of contemporary France. On the other hand, by culling out the good features in the French system and applying them to American conditions, the society could accomplish a corresponding amount of good. Neither of these courses are hinted at in the constitution and by-laws of the society. We note that the *American Architect* is at a loss to understand why the gentlemen composing this new organization should get together by themselves, far from the other architectural organizations. Is it possible that the *American Architect* does not appreciate the significance of the Beaux-Arts movement? What is the *Architectural Review* doing that its near neighbor is so plunged in medieval darkness? We would respectfully call the *Review's* attention to the *Architect's* condition and beg it to enlighten it. For our own part we view the society as a good sign of the times. It is well that the Beaux-Arts men should get together by themselves, and listen only to the sacred voice of the Beaux-Arts prophet extolling the excellence of the Beaux-Arts product. It is well also that they should be known apart from others, so that when the great American public, seeking out practical buildings in a practical age will know whom to go to in order to obtain the most extravagantly-planned buildings designed in the latest Parisian styles. We note that "any one who by reason of his efforts and assistance shall have contributed to the welfare and success of this society and the attainment of its objects and aims shall be eligible as an honorary member." The editor of the *Architectural Review* cannot—alas!—be a member of the society, but he clearly deserves honorary membership. We beg leave to nominate him for that distinguished honor from the hands of the Beaux-Arts Society of Architects.

"IF it is asked us," remarks the *Archi-*

tectural Review, in replying to some previous remarks in these pages on its position on the education of architects, "What is a Fine Art? we can answer, It is an art operating upon a subject which is not necessary for the physical or material prosperity of man. And such are music, literature, painting, sculpture, and architecture." We must object to this. This is a subjunctive definition, and represents only the *Architectural Review's* way of looking at architecture and defining it. It is a definition that will not bear the test of history, and unless it does that all the wisdom in the world will not help it. And not only will it not bear the test of history, but it is absolutely contradictory to history. Architecture, in its origin, was not an art, or anything else "operating upon a subject which is not necessary for the physical or material prosperity of man." On the contrary, every writer on architecture should know, though the *Review* appears to be ignorant of it, that architecture originated in the effort of man to provide himself with shelter. Its origin was entirely utilitarian, though in process of time a freer use was made of the materials employed in it, and it assumed that phase which is commonly called artistic. This was a late development, and simply an outcome of the initial stage. And though we have long since passed this primitive stage and discarded its forms, we have not reached a point at which we can afford to ignore it in considering the meaning and value of architecture. We will grant at once that, on a definition that plainly ignores the facts of history, it is quite possible to erect any sort of a superstructure one chooses. When one undertakes to teach young men in the broadest subject under the sun, with an historical past that extends almost in a continuous line to the very advent of the human race upon the earth, and out of this vast epoch of time selects only a few monuments from the period nearest one's own, and seeks to bring the whole vast subject under a meaning arbitrarily given to them, it is obvious that almost any sort of theory may be suggested, any sort of belief formulated, any sort of practice put into execution—more pitiable than the spectacle of the blind leading the blind, for it is men of culture and of education, with the amplest facilities for acquiring knowledge, deliberately shutting out whole centuries of work and labor in order to erect an artificial fabric upon an artificial base to conform to a preconceived personal preference.

In many respects the problem presented by the high building is the most important now before the American architect. In no other land is this problem receiving so much attention as here, nowhere else are so many architects engaged upon it, nowhere else does such architecture bring such rich results to the practitioner. It is not the only problem the American architect has to consider, it is true, but it is certainly not second in importance to any other. Already it has become the typical building of America, although we as yet have only seen its beginnings. The engineering problems it involves have been amply treated by the engineer; its architectural treatment by the architect is still a matter of debate, while the question of its artistic treatment is, perhaps, the most difficult and least understood of all. Yet not wholly so, for a few architects have a number of times not only showed their understanding of the problem, but demonstrated their ability to treat it in a thoroughly successful manner. The Schiller Theater, of Chicago, to which reference has again and again been made in these pages, is, perhaps, the finest high building in the world. Certainly it has not yet been matched for grace and beauty of proportion, for appropriateness of elevation, for richness of decoration, applied in a thoroughly satisfactory manner. And the architects who made this building have made others equally successful and equally satisfactory in the manner in which they meet artistic requirements. This aspect of the question is as yet scarcely known in the east. The idea of a correct principle of high design which, when rigorously applied to a high building will produce successful and artistic results, does not appear to be admitted in New York, yet

once the nature of the problem is understood, and its solution attempted on the lines suggested by this understanding, a satisfactory result can scarcely be avoided. The trouble lies in the gaining of this comprehension. Architects are so accustomed to low designing, to heights not exceeding six or seven stories or less, and into which the element of width enters in a more or less definite manner, that they seem unwilling to cast aside the traditionary methods acquired in such work when they approach a problem that is three times as high as it is broad, or more, and that may range in altitude anywhere from ten to twenty stories. Such a problem is quite unlike anything ever before submitted to the architect, and it is no wonder that under the circumstances the failures should exceed the successes. There is, however, no reason in the problem itself why it should not be treated successfully, and a number of examples, chiefly in Chicago and in St. Louis, show how this can be done.

NOT to indulge in specific examples it is sufficient to note that, in making a high design, it is imperative that the architect start out with a full conception of the fact that it is something entirely new under the sun. There have been high buildings of various types and forms in various previous epochs, but nothing that in any way approaches the modern commercial high building, built not for art but for income, a monument, not to the honor of its builder, but to his wealth, and designed, not to perpetuate his name but to supply his descendants with a good rich income so long as the structure is kept up to the top notch of modern requirements and it remains in their unencumbered possession. We need not stop to enter into the multitude of details and the variety of conditions that surround the designing of the high building of to-day,—conditions and details so numerous and varied as almost to deprive the architect of his claim to originality. But granting the newness of the problem, the next fact to consider is that the high building, being a vertical building, must be treated in a vertical manner. In other words, a high front is something to glory in, not to be ashamed of. The introduction of horizontal lines, of variety of motifs, of piling on of features one over the other, are as much to be avoided in a logical consistent high design as if it were impossible to combine them. The verticality of the high building is suggested and insisted on, not only by the vertical lines of the steel frame on which the building is carried, but by the manner in which such treatment emphasizes the height of the building. It never pays to avoid the truth, and if a building is to be twenty stories high there is no reason in itself why each one of the twenty should not be shown in the façade. The high design, like every other design, needs to be treated in a reasonable manner, studied in the light of its own conditions, solved as they suggest. The high front, as has been the case with every other sort of front prior to the seventeenth century, must be a logical outcome of the building and its necessities. Limited by the momentary considerations which force him to build his façade on a straight line, the modern architect is unable to exhibit exteriorily the diversity of plan that is possible in buildings planned on a freer system. To be successful the architect must rid himself of all his preconceived notions. He must admit the question is new, he must rid himself of the idea of proportioning a front whose size is given him at the outset, he must perceive that only in a very limited sense of the word can he express his plan outwardly, and perhaps not be able to do so at all; and he must further be prepared to maintain that as the high building is new and is not found in the historic styles, he must dispense with them save in the way of detail. Thus equipped it will be possible for the thoughtful and artistic architect to produce successful and artistic high buildings, and when this becomes general the chiefest disgrace will be removed from the street architecture of the contemporary American city.

THE question of women architects is assuming greater importance every day. Already, perhaps, we have the woman

architect, since several edifices have been erected from the designs of women, and one or two architectural bodies have seen fit to set their seal of disapproval upon such people. The Architectural Association of London has been the latest organization to debate the admission of women to its sacred fold, with the result that, by an overwhelming vote, they were forbidden even a peep within the holy enclosure. It is not likely that this disastrous decision—yet it must be confessed it carries with it the weight of most august authority and conservatism—will have any effect in diminishing the supply of draftswomen. Of themselves there can be no reasonable objection to draftswomen—we are a little doubtful whether this is the word to use or not, but presume it will pass muster—provided they will perform the same work that men do, in as good a manner and for no higher wages. The average woman employé is more reliable than the average man employé, and there is no reason at all why, simply because a person is a woman, she should be debarred from following the pursuit of drafting if she has a natural aptitude for it. From draftswomen to woman architect is quite a distance, and it is in bridging this that the greatest difficulties are likely to be interposed and the greatest opposition manifested. The question is not a complex one, however, and surely, if men cannot maintain their supremacy as architects without legislating the women outside the profession, the sooner they experience the competition with women in their own profession the better it will be for art and the public at large. We must, however, protest against any notion that architecture is a "lady-like" art, easy to practice, and "genteel." Architecture is an extremely difficult and complex profession, requiring the widest knowledge and returning success only through the most arduous exertions. One extremely potent cause for much of the bad architecture of the day is the need of a broader education by those who practise it. The women must not permit themselves to be attracted to it because it so "easy."

DRAFTSWOMEN in America are likely to increase largely through the opportunities of study afforded by the New York School of Applied Design for Women. This is one of the newer educational institutions in the metropolis and has been founded to provide working girls with the means of learning artistic modes of support. The architectural section is only a small part of the work the School has undertaken, instruction being offered in carpet and wall-paper design, in book-covers and in other allied forms of decorative art; but the architectural school is the only portion we are concerned with. This is conducted by architects and draftsmen from some of the leading offices of New York, the aim being to give the students the benefits of practical and actual experience. Other instructors are similarly practical men who give up a few hours a week to the supervision of the work, and the school is thus enabled to offer a more thorough course in practical art work than is provided by any other institution in New York, and on a system wholly different from that in which the work is directed by a professor who has long been a stranger to the realities of the work he is teaching. Although only in the first years of its existence, the New York School of Applied Design for Women has made a most creditable record for itself. Its system of training is, of course, the theoretical one of the Beaux-Arts and its American allies, but within the limits thus set its students show a most commendable industry, a skill proportionate to the time they have given to their work, and, in some cases, a marked degree of artistic talent. There is no reason at all to doubt that when the School has been a little longer in operation, when its courses have been further systematized and its students have had the advantage of several years' training, its graduates will be fully as well equipped to enter architects' offices as assistants as the graduates of any American school of architecture. How far this School may help in determining the question of the women architect in America is not yet clear. Its aim at present is only to train draftswomen. The higher grade may come in time, but when

it does there is every reason to believe that those who seek it will be fully aware of the difficulties they must contend with and the battles they will have to fight, not only for themselves, their profession and their art, but to gain the business whereby they may earn a livelihood. In commending this School and its students to our readers it is just to add that its success is chiefly due to Mrs. Dunlap Hopkins, chairman of its board of managers, who has interested not only herself but many others in the school, and who has already had the very enviable satisfaction of finding her efforts crowned with success.

A VERY great deal of interest has lately been manifested in New York over the competition for a twenty-story office-building for the American Surety Company, to be placed on an 85-foot lot on a corner site adjoining the Equitable building. Nine architects were invited to take part in the competition, viz., Messrs. McKim, Mead & White, George B. Post, Carrère & Hastings, Bruce Price, LeBrun & Sons, R. W. Gibson, W. Wheeler Smith, John R. Thomas, and G. Martin Huss. Mr. Richard M. Hunt was the professional adviser of the company, and the building was finally awarded to Mr. Price. Whether it was from the known inclination of the professional adviser or from the personal inclination of the competing architects, it was somewhat significant that classic or Renaissance designs predominated. The richest and most elaborate design and of most extraordinary merit in itself was that of Messrs. Carrère & Hastings; one of the severest was that of Mr. Bruce Price, to whom the building was awarded. It is possible there may be a lesson in this and possibly not. At least it is certain that never before were classic structures designed to be built twenty stories high, and the chief interest in the competition arises from the various uses made of classic motifs by the competing architects. Without entering into specific illustration in the least it is sufficient to state in the broadest way that the method selected was to introduce motifs of three or four stories decorated with different orders, in engaged columns or with pilasters, filling up the space by the introduction of entresol stories and other devices to fill out the total number of stories. The difficulty of the problem was further complicated by the relatively small size of the lot. This was only about 85 feet square, so that the building naturally assumed tower-like proportions. Somewhat fortunately the adjoining structures to the south and east, from which points the building will be readily seen from the bay, are of such a nature that several of the competing architects suggested carrying the same motif around the whole of the upper part, thus making the building an actual tower, and this idea, we understand, will be applied to the design selected for execution. It was perhaps somewhat significant of the natural tendencies of New York architects towards the horizontal in all things, as well as a practical illustration of the unadaptability of the classic to very high structures, that only in one design, that of Messrs. Gibson and Smith, was a style selected that permitted vertical treatment. Even this did not go as far in the vertical direction as it should, but it was a most interesting study. Whether this competition will have any permanent effect on the betterment of New York commercial architecture remains to be seen; meanwhile the decision of this company to build so high a building will quite likely be followed by others, until the problem of New York's restricted area shall have been solved by the upward tendencies of its buildings.

THERE is no reason at all why newspaper reporters, whose lives are spent in making observations and in ferreting out facts,—albeit the facts would sometimes be better without the ferreting,—should write successful magazine articles of observation and of travel, but it is quite natural that, after series of such papers have been written, the results should be put into book form and thus given a dignity they may not have had in the more perishable state of newspaper and periodical literature. It is not often that this process pro-

duces such a notable work as Mr. Julian Ralph has accomplished in his book* on the West. Dealing primarily with the present conditions and future possibilities of the new commonwealths of the United States, it contains a quantity of interesting details on the cities of the west to which the student of municipal development, in which the architect has so important a place, may well give his attention. Quite naturally, in speaking of Chicago, Mr. Ralph has a good deal to say of its office-buildings and the general architectural characteristics of the city. Without undertaking to critically treat these splendid monuments of Chicago push and energy, Mr. Ralph is quick to recognize the fact that the development of the high office-building has reached a more notable stage in Chicago than in New York. "It is a great mistake," he writes, "to think that we in New York possess all the elegant, rich, and ornamental outgrowths of taste, or that we know better than the west what are the luxuries and comforts of the age." But with all his breadth of view he is unable to understand or appreciate the merits of the purely commercial designs of which Chicago has an unusual number, for he tells us that some of them "are artistically designed, and hide their height in well-balanced proportions. A few are mere boxes punctured with window-holes, and stand above their neighbors like great hitching-posts,"—a complex simile that no one but a newspaper-man would think of using. The general criticism is wrong, for there is no reason why a high building should hide its height in well-balanced proportions or in anything else. Height is not an element to be afraid or ashamed of in a high building, though as one brought up in New York there is no wonder Mr. Ralph thinks so. But this is a detail in specialism, perhaps, for which our author should not be held too strictly accountable. The book is a most impressive picture of the great west and will unquestionably do a vast deal of good in familiarizing people with the resources of a large part of our country that is too of much a closed book to the traveled American.

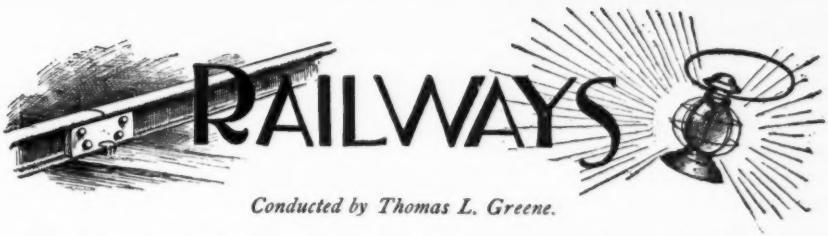
* *Our Great West.* By Julian Ralph. New York: Harper & Brothers. 1893.

IN THE ENGINEERING MAGAZINE for September, 1891, in an article on "Recent Tendencies in Architecture," we find the following statements:

> Exaggerated edifices are bad enough in their way, but when no attempt is made to conform to the exacting on conditions of height they become positive inflictions. The Tower building . . . is one of the most conspicuous illustrations of this grade of work. In it the architect has exaggerated every line which tends to increase its apparent height and unfortunate narrowness and the result is almost painful. . . . . In all the upward tendency it has been greatly exaggerated.

True enough, so far as the Tower building is concerned, for it is one of the most distressing designs in New York; or rather it was when it was built, for the nerves of the passers-by are set on edge by many a more striking monster built since then. In *Scribner's Magazine* for March, 1893, the same writer in an article on "The High Building and its Art," has this to say:

> A high building is necessarily big; it cannot be hid, nor can it by any physical process be made smaller than its physical bulk necessitates. If the high building is to be an artistic success this quality must be admitted at the beginning. Notwithstanding this, many architects, especially in the seaboard cities, apparently believe they can make the impossible real, and reduce the apparent height of the high building by dividing it horizontally as often as their imagination or taste will permit. . . . . If he [the architect] cannot treat verticality as an artistic quality he must learn to do so, just as he has had to learn every other step in architectural progress. . . . . Vertical design being the natural system to be followed in high façade design, in which the superstructure naturally grows out of the basement, and, in turn, forms itself the natural base of the crowning frieze, a similar following of natural law offers the safest guide in the determination and use of ornament.



Conducted by Thomas L. Greene.

THE shocking accident on the Delaware, Lackawanna and Western railroad at Hackensack meadows, in January, by which twelve persons lost their lives and many were injured, brings up a number of important questions of railway policy. This company has long been prosperous, principally on account of its coal traffic. The beautiful country through which it runs for twenty-five miles out of New York city has led many New-Yorkers to make their homes there, so that the Lackawanna enjoys a large commuting traffic. It has been operated generally on old-fashioned methods, not having changed its policy with the gradual advancement in operating management on the neighboring roads. The Morris and Essex division has not before had a serious accident, its immunity being due largely to the painstaking oversight of the officers and the excellent character of the employés, many of whom have been in the service of the company for over twenty years. The theory of the company has always been "men rather than machines."

It seems clear enough, however, that the Hackensack disaster was due primarily to the absence of a block system. The oncoming engine-driver was running his train in the fog faster than the preceding train which he telescoped, but no evidence has been produced to show that he was guilty of extreme negligence. The rear brakeman had started back to warn the approaching train, but was too late. The real fault lies upon the company, which, by not earlier adopting a system of signals, left the engine-runners in ignorance of the position of trains in front of them,—information to which they were justly entitled. Since the accident the Lackawanna company has contracted to put in the Hall track-circuit system of signals in half-mile blocks from Hoboken to South Orange, and the signals are to be extended gradually to cover the whole road. The time-table of the Lackawanna has trains within four minutes of each other. Experience shows in such cases that one of two things is likely to happen: either the schedule time is not kept, or trains, on mere flag protection, are run dangerously near each other. It is a peculiar advantage of the block system, in cases of crowded traffic, that by its aid trains can run at shorter intervals than before, and yet with greater speed and safety. In time, four minutes is but a brief interval when trains are running rapidly; but four minutes at sixty miles an hour means a space interval of four miles. We may allow trains within a mile of each other if we are sure of our apparatus, and that they will under no circumstances approach nearer; but we can never be sure that trains run on the time interval are keeping that number of minutes apart. Moreover, in blocking, we substitute a signal at a fixed spot, where runners get accustomed to look for it regularly, for a signal by flag or torpedo at unexpected places, and which indeed may never be given when most needed. The motto "man *versus* apparatus" should be changed to "man *and* apparatus."

IT has not been sufficiently noticed in the newspapers that to all the horrors of the Lackawanna wreck fire was not added. Every one will recall instances where the broken cars caught fire from the stoves, perhaps subjecting the injured and imprisoned passengers to a horrible death. To the credit of the Lackawanna it should be stated that the company had already adopted the plan of heating the coaches from the engine by the Gold system. In

the Hackensack accident this improvement saved much suffering and perhaps many lives. There is no excuse for the "deadly car-stove" since experience has demonstrated the feasibility of heating the coaches by locomotive steam. It is announced that the Baltimore and Ohio are about changing the heating of all their equipment. Such roads as the New York Central have already done so.

ANOTHER matter which the Lackawanna disaster brings up is the strength of our passenger coaches. Of course nothing can withstand a hard blow from a rapidly-moving train, but there is evidence in plenty that a more careful building of passenger-cars will do much to check telescoping. Some of the coaches run by our railways are mere shells, whose frames are just strong enough to hold the car together in ordinary running. This ought not to be so. It has often been remarked that Pullman or Wagner cars have withstood the shock of collisions which have wrecked the ordinary coaches in the same train. Cheapness is out of place in the construction of cars in which passengers are conveyed and which at any moment may be the only protection of travelers from death or injury. Another thing in the same connection is the value of the vestibule device. Not only do cars with this attachment ride more smoothly and comfortably, not only is the passage from car to car thus made easy and safe, but cars so fitted out bear up better under collisions. When we read that one car in the Lackawanna accident was forced almost entirely through another, though the train had slowed down to fifteen or twenty miles an hour, we are compelled to think that the time has come for new methods and new standards in the car-building department of our railways.

IN a paper read recently before the New England Railroad Club, Professor C. Frank Allen, of the Massachusetts Institute of Technology, gave some fresh figures on an old but always important subject: the dollar-and-cent disadvantages of grades and curves. The relation between the building or improvement of railways and the resulting effect upon the economy of operation has of course long been studied by civil engineers, but, if we except Mr. Wellington's book, the subject can scarcely be said to have a literature. After quoting the census figures of cost of running a train one mile, divided by groups into fixed and variable, Mr. Allen properly says that many of these items—such as station expenses—will not be affected by one mile extra distance; coal will be increased and so will car-mileage, as well as track-repairs. Train wages, if based on miles run, will be increased, and so, though to a less degree, will car- and engine-repairs. If then we assume $1 as the average cost per train-mile, Mr. Allen's estimate of the train cost for an extra mile is 35 cents; at 80 cents average cost, the extra mile would add 28 cents. One train each way per day, or 730 per year, would, therefore, at 28 cents, amount to $204.40. This capitalized at 5 per cent. would be $4088, the amount which the civil engineer can afford to pay to avoid the mile of distance at two trains per day. At ten trains this amount of course would be five times as much. So much for operating expenses, but other things must be considered, such as the effect of the odd mile in pro-rating or in the fares received if so much a mile, etc.

PROFESSOR ALLEN'S estimates on curvature are that at 317 the extra cost per train mile is 24 cents. One degree is estimated at 8 cents per train mile, or 58 cents for one train each way; for 10 trains $5.80, amounting if capitalized to $111.68, which may be spent to avoid that one degree of curvature.

On gradients, the estimates are based on an operating division 100 miles long, and only those trains are taken whose loads would be thus lightened throughout the entire division. It is also assumed that the question is between a 37-feet and a 53-feet grade, and the engine an average consolidation locomotive. At 80 cents for the average cost of trains, and for ten trains daily, capitalized at 5 per cent., the amount reaches $1,600,000 of capital. In known

cases the exact disadvantage can be calculated. Mr. P. H. Dudley made some calculations on the Lake Shore which showed that if the train resistance could be reduced one-quarter, a saving in operating expense of $750,000 per year would follow. Even the difference in train-resistance, as between iron rails with low joints and steel rails with good ballast and ties, was found to be as high as 57 per cent. "The engineer who figures only upon the comparative cost of heavy and of light rails for a series of years stops far short of his duty."

AFTER further discussion of yard terminals and the like, Professor Allen closes with a plea (1) for the better attention of civil engineers to this branch of their profession, and (2) for the attention of railway managers to the importance of this kind of work when done by competent hands. The question is often asked, in view of the decline in railway building, whether the profession of civil engineering is any longer a good one to follow. But this is not the real question; that question is whether the young engineer is willing to confine himself to one branch of his trade. Unless all signs fail, the railways of the United States have entered a period of low earnings; the burning wish is to reduce operating expenses, not merely by discharging hands, but by economics founded on scientific principles. The civil engineer who can demonstrate such savings without sacrificing efficiency will find the whole field open to him; but he must change his studies from railway-building to railway-operating.

AS a corollary it may be safely stated that the need of the average railway manager today is technical knowledge. "Practical" railway-men have long held sway, but now is the time for the theorist. The railway world, if it appreciated its real position, would demand men who know how to combine and classify the facts which the rule-of-thumb officers have learned in their long experience. In short, railroading is more and more getting upon a scientific basis where principles can be evolved from the facts collected, and where trained observation can be directed towards cheapening the cost of running and handling trains. For this effort the civil engineer and the mechanical engineer are fitted by their preliminary education; but they must apply their knowledge strictly to the questions at hand.

THE New York State board of railroad commissioners have applied themselves intelligently and conservatively to the study of some of our railway problems. There is the problem of grade-crossing, for example. We frequently hear of the killing and maiming of persons at highway crossings. One road in New York State has 1300 such wagon-road crossings at grade unprotected and 460 with gates or flagmen. Moreover, fast trains add greatly to the danger, for a train covering 120 feet in a second runs a quarter of a mile in ten seconds. Drivers of wagons may think such a train a long distance away and attempt the passage, while in reality the engine is almost on them.

But the enormous cost is the great difficulty in the way of removing such crossings, and, though it may sound cold-blooded to say it, it is true that safety is largely a commercial question and has its price. If the people want the abolition of grade-crossings they must pay for it in some form. The New York board suggest that no new road be allowed to make a new grade-crossing. As to existing crossings, the right of the company to its position is recognized. The Massachusetts law has worked out fairly well. It divides the cost of removing grade crossings between the town, the railway, and the State as representing the traveling public. The minimum share paid by the State is 25 per cent. and by the town 10 per cent.; the former may be increased and the latter diminished. The remaining 65 per cent. is paid by the company. Massachusetts appropriated $500,000 yearly for ten years, which has not all been spent. Here is a practical example which has not caused the comment in other States which its merits deserve. In England, as we know all crossings are eliminated when the

railway is built; but on this and other accounts the capitalization of railways in Great Britain is over $200,000 per mile.

Another most appropriate suggestion of the New York commissioners is that crossings of electric- and steam-railways should be protected by interlocking plants. The multiplication of trolley lines in the country adds greatly to the dangers of crossings where these and the steam-railways meet, if no safeguards are provided.

ASIDE from the cut rates and railway wars with which we are familiar, and aside also from steady reduction in receipts brought about through federal and State legislation, an unsuspected cause of decreased revenue is made public in *The Station Agent*, by Auditor McCain, of the interstate commerce commission. This is the decrease of revenue from changes in freight classification. In 1886, the year before the interstate act was passed, but 15 per cent. of the articles named in the classification east of the Mississippi river had lower rates for carloads; now 62 per cent. are so favored. There has also been a gradual but persistent fall in rates from a lowering of classification by items, indicating in each case a lowering of rates. The percentages are stated by Mr. McCain in tabulated form as follows:

	Classification of 1886.		Classification of 1893.	
Total no. of descriptions	1,000		5,600	
Proportion 1st class	32%	67%	22%	53%
Proportion 2d class	24%		12%	
Proportion 3d class	11%		19%	
Proportion 4th class	31%	33%	19%	47%
Proportion 5th class	2%		23%	
Proportion 6th class	0		5%	

In 1886 the number of articles charged in fourth-class or lower was 33 per cent. of all; in 1893 the proportion had risen to 47 per cent. In 1886 the average rate on all articles from New York to Chicago was 63 cents; in 1893 it was 48 cents. This is a proof, if another was needed, of the steady whittling away of railway revenues which, if not checked or met by scientific economies, will work disaster to the capital now invested in our companies. Nor should we rely for a defense upon a return of prosperity and of a larger volume of traffic if unaccompanied by more fairness to our carriers. It is the margin of profit, now too low, which should be increased. The interests dependent directly or indirectly upon transportation are so vast and important as to make this reflection of grave moment.

MR. C. P. HUNTINGTON has written another letter in which his former opinion is repeated that no new lines of railway are likely to be built in Texas so long as the present harsh opposition to railways continues there. It does not throw doubt upon Mr. Huntington's prophecy to find that several hundred miles of road were actually constructed in that State in 1893, because this mileage was built by the Rock Island and Kansas-Texas companies as extensions of lines necessary to complete their systems. Capital is very timid now from well-known causes, and surely none of it can be secured in favor of any new enterprise in States which seem to hold, in practice if not in theory, to the socialistic doctrine that capital is a form of robbery. Since in such States it is not their own money which is imperilled by drastic legislation, it is easy to suppose that any compulsory lowering of profits will not hurt the home people. Usually it takes some degree of clear thinking, and perhaps experience, before the western or southern farmer sees that an injury to the railway is in the end an injury to himself.

ADMITTING that some restraining legislation is allowable—though even this is economically doubtful—it seems strange that but few States have tried the remedy of greater freedom. If banks charge high rates of interest on loans the best course is not to attack the banks, but to welcome more of them by enacting laws which shall afford all reasonable protection to the lender. The safer and better the loans the more will banks compete for them, if allowed to, with a consequent gradual decline in the rates of interest paid. In like manner oppressing the carriers merely prevents other railways from coming into the territory, which

would be certain to be the result if the profits were unduly high. The commercial test is slow but sure. Combination for a while may arrest a decline to the common level of profits, but only for a while. Combinations among modern industries are formed to prevent insolvency rather than to extort high charges. The tendency of the age is entirely on the side of the consumer, and no oppressive laws in Texas or elsewhere are at present needed to hasten the movement. But reduced train service and lower wages—or an equivalent in a smaller number of men employed---will inevitably follow a loss of profits. There was a time in our economic history when in every purchase and sale one party or the other was supposed to have lost something. We now believe the more enlightened theory that trading benefits both parties. Applying this principle to the State's relations to carriers, it is to be observed that if the State would prosper in all its interests the railway must prosper with it.

THE interstate commission in its annual report renews for the third or fourth time its recommendation that a uniform classification of freight be made compulsory by law, and that the commission or some public authority be directed to enter upon the work. In spite of this recommendation, it is well to make haste slowly. Undoubtedly the three or four different classifications now in use ought to be brought into uniformity as fast as commercial conditions permit, but no faster. The inconvenience arising from their differences is partly exaggerated and partly ineradicable: rate-quoting for long distances must always remain in railway hands, because dangerous in any other. The ease in figuring out a combination rate under a national and common classification would be secured at the expense of that more important quality, conformity with trade conditions. The division of articles into classes is merely an aid in fixing their rates. In short, classification is rate-making. Now, the art of rate-making consists in conforming tariffs to the facts in each case. These trade facts and circumstances differ in different sections of our country. Cotton is a staple in some States, and wheat or corn in others. The laws of good trading require that a staple crop yielding large tonnage should be carried more cheaply than the occasional shipment. Hence cotton is carried at a proportionately lower rate in Georgia than in Minnesota, with wheat *vice versa*. These cannot be put in the same list of articles in the north and the south without doing violence to commercial common sense. In the same way both rates and classification are lower in the trunk-line or eastern territory than in the States west of the Mississippi, for the reason that the volume of traffic is lower in the east and the pressure of business competition greater; so the railway schedules conform to the facts. To put these two classifications together would be convenient, but might do a commercial injustice. Of course the railways of each section, after adopting a universal classification, would try to obtain their usual revenue by readjusting class rates so as to fit the changes, so far as possible; but practical railwaymen know that commodity rates as they are called—special rates on special articles for special reasons—would quickly nullify the supposed harmony, leaving marters just where they are now. The true position to take is that harmony in classification of freight should follow—not precede—the approach of equality in the business conditions and scale of profits of the different sections of our country.

MECHANICAL ENGINEERING

Conducted by Henry Harrison Suplee.

"ENGINEERING," said the veteran James Nasmyth, "is common sense applied to the use of materials." Coming, as it does, from one who was the most practical of mechanical engineers, and yet who at the same time rated theoretical research at its fullest value, this definition is worthy to be borne in mind more than ever at the present time, when theory and practice are constantly shifting, when the theory of yesterday is the practice of to-day and may be shelved to-morrow, and when the "common sense," which has been said to be one of the most "uncommon" things in the world, is more to be desired than ever. But "common sense applied to the use of materials" is not so uncommon a thing after all, and it is one of the encouraging signs of the times that the so-called theoretical man is becoming in many ways very practical and the practical man truly and sensibly theoretical, and that the noble art and science of engineering is being mightily advanced thereby.

AN excellent instance of the blending of theory and practice is found in the increasing use of measuring appliances of precision in the work-shop. The skilful lathe hand makes his "running," "shrinking," or "forcing" fit by the use of a pair of calipers, a delicately-trained sense of touch, and a judicious admixture of common sense. The writer well remembers how just such a practical man rather objected to the idea of calculating the proper allowance for such dimensions, and, instead of antagonizing him, he was induced to permit the results of his skill and experience to be placed on record by having very careful measurements of a number of shrinking fits made by him tabulated for reference. When he was subsequently shown how closely the measurements of his "practical" allowances agreed with the professor's theoretical calculations his feelings first expressed themselves in pleased congratulations to the professor upon the fact that his calculations were so nearly correct, and this frame of mind was soon followed by a sense of personal pride in the fact that he himself ranked with the educated theorist as a peer and a companion. Since that time—for it was a number of years ago—the use in the work-shop of closely calculated dimensions has become sufficiently common to cease to attract attention, but there are many ways in which a similar union of practice and theory ought to be made.

STANDING one day not long ago under a modern high-speed electric traveling-crane, it was impossible to avoid commenting upon the ease with which the operator steered the heavy burden which hung upon the hook between the various obstructions upon the erecting floor. By a judicious combination of bridge and trolley motions with occasional hoisting and lowering, the hook and its load threaded their way rapidly down the long building. The man in the "cage" had thoroughly mastered the combinations of the three "variables" of the three-dimensioned space in which his work lay, and had not only learned to think in three dimensions, but had also grasped the fundamental meaning of the "rate" of speed involved in the description of the curved path of the load.

It would have been a most instructive lesson to any professor of differential and integral calculus to gaze silently at this practical illustration of the combination of variable values into a curved path. The workman's use of his grasp of the laws of motion as expressed and limited by the rectangular coördinates in the instance of a traveling-crane is in many respects as scientific and complete as the mathematician's

use of his command of the calculus. Indeed, the true use of mathematics in engineering is to obtain results which shall be applicable in practice, or to investigate phenomena which have already been observed and demand solution in order to be available for future use. Some day we shall have for the use and service of the practical man such useful and intelligent treatises upon practical mathematics as the masterly works of Lubsen, and when the practical workman finds in the books of the student clear and intelligible answers to the problems which every day confront him he will require no other incentive to become an earnest student with his head as he has already been with his hands.

THE subject of the availability of electricity as a motive power for main-line railway service has been recently discussed in Germany by the *Verein fur Eisenbaukunde*, and Herr Ober-Baurath Stambke in the discussion brought out the following points of criticism against the steam locomotive:

1. The weight of the locomotive and consequent loss of efficiency due to the power required to propel the engine itself, especially at high speeds.

2. The loss due to the inertia of the reciprocating parts, and the increasing danger at high speeds from this source.

3. The effect of the centrifugal force of the counterweights in the driving-wheels, this limiting the continuous safe speed to about sixty to seventy miles per hour.

4. The inferior economy of locomotive boilers as compared to that of the forms available for use in power-houses in stationary service.

5. The fact that in the present forms of locomotives increased power can be obtained only by later cut-off and consequent reduction in economy of use of steam.

Against these points the following advantages possible in the use of electric power were cited:

1. The total absence of weight of electric energy itself, and the slight weight of the apparatus for transmitting it from the stationary point to the moving body.

2. The absence of necessity of a special locomotive engine, it being possible to apply the power to the axles of each car, thus utilizing the adhesion of each car instead of depending upon that of the locomotive only.

3. The higher economy attainable with a stationary steam-plant in nearly every respect as compared with the same amount of power generated in locomotive engines, together with the fact that only the motors are carried on the cars and not the entire plant.

4. The possibility of utilizing natural sources of power, such as water-power, as the propelling power.

5. The use of rotary instead of reciprocating motors, thus dispensing entirely with the objectionable reciprocating parts.

In discussing these points Herr Stambke admitted freely that the present state of the art did not admit of the substitution of electricity for steam as a motive power for main-line traffic, but suggested that it should be introduced upon feeder lines connecting with the stations of the present steam roads, thus paving the way for ultimate adoption on the main lines.

THE successful start which has been made of the turbines of the great paper-mill at Niagara Falls, forming as it does the initial step in the utilization of this great natural source of power, will be watched with especial interest from the fact that it is but a preliminary to the far greater experiment of the installation of the plant of the Niagara Falls Power Co., which is expected to be inaugurated next summer. The wheels of the paper-mill have nothing in common with those of the power company except the fact that they discharge into the same tunnel and open under practically the same head, being placed in a separate shaft and being of a different construction as well. At the same time the conditions are sufficiently similar to enable valuable information to be obtained as to the working of such wheels under so great a head, and thus to contribute toward the greater certainty of success of the main enterprise.

The greatest care has been taken to prevent any solid bodies from entering the

inlet and thus getting to the wheels, the water being practically filtered through a system of intercepting devices well calculated to detain anything which might possibly cause injury. It will be most interesting to observe to what extent the action of ice nodules will affect the wheels, this being one of the uncertain elements which experience alone can resolve. As one of the most eminent of the engineers connected with the enterprise remarked, there is a vast amount of guessing involved in an installation of such magnitude, notwithstanding all the care which may be given. The entire absence of precedent for many of the points involved requires many questions to be determined almost entirely by the judgment of those having the work in charge, and there is here ample evidence of the exercise of that "common sense applied to the use of materials" which is indeed the highest attainment of the engineer.

THE interesting paper which was read at the recent gathering of a number of members of the American Society of Mechanical Engineers by F. F. Hemenway, upon the subject of "Steam-Engines at the World's Fair," developed a discussion which may be said to furnish some indications as to the lines of steam-engine construction upon which the future advances may be expected.

With few exceptions, the engines exhibited at Chicago revealed rather the slow but sure gain resulting from the careful application of well-known methods of construction than they did any startling novelties in design or invention. Extremely high rotative speeds were the exception, although the average speed has undoubtedly been materially raised during the years that have elapsed since the Centennial Exhibition. The standard of economy has steadily crept upwards from the thirty pounds of water per horse-power of eighteen years ago until fifteen pounds has come to be considered "good," with thirteen pounds and a small fraction just before the designer's eyes, like the proverbial bunch of hay before the progressive nag to urge him forward.

AMONG the few exceptions in modern steam-engines noted above, the so-called "steam-turbine" appears to offer possibilities which may work a notable revolution in the design of steam motors. When we attempt to realize the fact that the steam-turbine is claimed to be capable of operating successfully with a steam economy and range of expansion practically equal to the average high-class reciprocating engine, and to possess all the advantages which the most sanguine inventor of the bygone rotary engines ever ventured to claim, and, furthermore, to do this at a velocity of 25,000 to 30,000 revolutions per minute; when these claims are seriously brought forward and their substantiation reasonably assured, it is indeed time to wonder whether at the next exposition the Allis quadruple-expansion engine may not appear as antiquated beside its impending rival, as did the once famous Edison "Jumbo" dynamo, mounted upon its pedestal in the center of the Electricity building in the midst of its successors. There seems to be little doubt that the steam-turbine is to be the next in the field, if indeed it has not already arrived, and the next few years may see transformations in this direction which can now only be imagined.

ONE of the interesting transformations which has taken place in modern engineering practice rather quietly, but none the less definitely on that account, is the subdivision of motors in many instances, in preference to the use of transmitting devices for the distribution of power. This has become the case notably in the later forms of cranes and hoisting machinery. The earlier types of power cranes, whether jib or power travelers, were constructed to receive the power from a stationary source using flying rope, square shaft, or similar transmitting mechanism. In traveling-cranes the power then required subdivision to perform the various functions of hoisting and lowering, trolley travel and bridge travel, which, together with the provision for necessary changes of speed, reversal, etc., involved many parts and constant complication, so that such a crane has

rightly been called one of the most highly organized machines in use. The advent of electricity as a means of transmitting power soon became apparent for use in such cranes, but at first it was used merely to transmit the power from the stationary source to the moving bridge, a single motor furnishing the power which was then subdivided by mechanical appliances as before. This intermediate stage, however, was soon succeeded by the more recent forms in which a separate motor is used for each function, the multiplication of motors being found decidedly preferable to the use of the mechanism otherwise necessary. The great electric traveling-cranes in Machinery Hall at the World's Fair, being made with two trolleys on one bridge, contained five motors, and each function was thus altogether independent of the others, all being controlled from the operator's cage with the greatest ease. This principle of subdivision is also seen in power steam-cranes, in which three independent, double-reversible engines have been found preferable to a single engine and clutch-transmitting mechanism. In rolling-mills, saw-mills, electric-power plants, and many similar situations, the advantages gained in the reduction, both in first cost and especially in cost of operation and maintenance by dispensing with much of the power transmitting mechanism, has been found to offset fully the slightly lower efficiency of the smaller engines, while the freedom from entire stoppage in case of breakdown is a feature which appeals especially to the practical man.

Probably this practice of the subdivision of power by the use of many separate motors is carried to its farthest extreme in modern ships of war, in which over one hundred auxiliary engines are sometimes found. This practice also brings out a point too often neglected by designers of power plant, viz., that the ultimate economy of the entire plant should be always kept in view, and should dominate the question of economy of any portion; it profits little to save 10 per cent. in the engine and waste 20 on the line-shafting.

THE many exhibits at Chicago revealed some curious contrasts to those who were interested in the historical side of engineering development, but among all the phases of the art of directing the forces of nature for the use and convenience of man, none, we may safely say, was shown at such wide extremes as the production of heat. In the great boiler-house by Machinery Hall were shown the most modern methods of burning liquid fuel; in the Electricity building electric welding and cooking by electricity claimed novelty at least in similar lines, but after looking at these one had only to turn his steps to the much-discussed Midway Plaisance to see performed before his own eyes the origination of fire in a few minutes by a half-naked South Sea Islander, using the primitive process of rubbing one piece of wood upon another. It did not detract from the interest of the operation to find that the ingenious and ingenuous savage expected to utilize the glowing coals he produced merely to light a cigarette which the observer was expected to furnish, and it was impossible to keep from reflecting upon the immense gap between the beginning and the following. The white pinnacles of Machinery Hall assumed a new meaning as they glistened before our eyes, and we tried to realize that in the smoldering sticks before us lay the cause, while yonder we beheld the effects, and we bowed to the smiling savage and handed him the cigarette for which he was still waiting; he had earned it many, many times over.

ONE of the noticeable features due to the continual introduction of mechanical appliances into every-day life is the increasing popular interest in mechanical subjects shown by many people who formerly would have paid little notice to such matters. Nearly every issue of the popular magazines contains matter which a few years ago would have been considered suitable only for strictly technical journals, while the publication of a magazine devoted to engineering and yet intended for general as well as professional readers would have been out of the question. It is not too much to predict that the next few years will witness a rapid

advance in popular interest in mechanical subjects, due not only to the existing causes, but also to the constantly-increasing introduction of systems of distribution of power. It is said that the late Professor Clerk Maxwell, when he first heard of the discovery of the reversibility of the Gramme dynamo and the consequent possibility of using it both as a generator and a motor, said it was the greatest discovery of the century evidently perceiving the revolution it would work in the entire practice of the generation and use of power. Not only may the small manufacturer ultimately compete with the great owner in the economy of cost of power, but the individual workman may come again to the position from which the concentration of power in the factory has displaced him; while not very far ahead may dimly be seen the sociological changes which the general use of the forces of nature by all, as part of the general right of existence, must surely bring to pass. Meanwhile the education of the great public in matters mechanical will go on quietly, but surely and rapidly, and in the light of what has been done it may well be worth while to watch thoughtfully for changes, the certainty of which is admitted and the manner of which is rapidly being revealed.

THE question of standard screw-threads and gages, which, fortunately, has been settled for many years in this country, is still being agitated in France. there being as yet no satisfactory standard of screw-threads adopted for use with the metric system. In Germany a modification of the Whitworth system, adapted to the metric system, has been adopted by the State railways, while the system of Delisle, differing from the English and American systems, has been recommended by the *Verein Deutscher Ingenieure.*

A committee of the French Société d'Encouragement has recently issued a report upon this subject, and, in view of the importance of the matter, this being about the only really weak point about the metric system as at present used, we Americans can stand upon the further shore of comfort and system to which we have successfully attained and look with interest upon the efforts of the members of the committee to wrestle with this increasingly difficult subject. We say increasingly difficult subject, for, as the report truly says, the earlier dates at which Whitworth and Sellers attacked the subject greatly simplified the task to them, and at present there are at least six well-used systems in France and fifteen or sixteen in Germany. Nearly every railroad in France has its own system of bolts and nuts, and, as it has already been well said, it is very much easier universally to adopt a new system than it is universally to throw away an old one, so that probably the greatest difficulty that the advocates of the proposed system will have to encounter will be the discontinuance of the systems now in use rather than the approval of the new one. It must not be forgotten, however, that the introduction of the metric system itself into Germany is as recent as the establishment of the empire, and the difficulties in the present instance are no greater than they were then.

Of the system itself there is little to be said, as it is more the fact of its existence than its construction that is here to be considered. Briefly, the pitch increases regularly by intervals of half a millimeter, a screw of 1 millimeter pitch being 6 millimeters diameter, and being numbered 0; the next being 1½ millimeters pitch, 10 millimeters, diameter, and numbered 1, and so on up to 10½ millimeters pitch, 154 millimeters diameter, numbered 19. The thread is made of an angle of 60°, the section being an equilateral triangle reduced by one-eighth of its depth top and bottom—being in fact the Sellers section without modification, this being considered by the committee capable of being executed with much greater accuracy and uniformity than the rounded thread of the Whitworth system.

It will be interesting to observe how the proposed system is received by the engineers and constructors of France, as a good screw-thread system has for a long time been needed to complete the metric system for workshop use.

CIVIL ENGINEERING.

Conducted by John C. Trautwine, Jr.

IN the days when Thomas Paine, patriot and theologian, was shocking the sense of propriety of his conservative neighbors by suggesting the utterly visionary possibility of an iron bridge, the as yet un-named "civil engineer"—if, indeed, he existed so early—might find himself called upon one day to design a church, the next to locate a road or canal, and the third to throw a bridge across a stream or to build a mill; and even down to the days when the railroad had proved that it had come to stay, we often saw one man combining all of the then-recognized offices of the civil, the mechanical, and the mining engineer with those of the architect. The electrical engineer had not yet been evolved.

To-day the vast extension of the engineering field and the enormous development of detail in each portion of it have necessitated a degree of specialization that could scarcely have been dreamed of by the generation just passed away. Yet it by no means follows that the several branches of the profession are thereby called or permitted to work independently of each other. On the contrary, it would seem that the more sharply defined their pursuits become, the more intimately they are compelled to coöperate with each other in any given work. A great railroad, for instance, calls into exercise the faculties of civil engineers of all classes.

A striking instance of this interaction of engineers in the several branches of the profession is furnished in that spectacular work by which the power of Niagara, a power which has hitherto ministered chiefly to the sentimental side of man's nature and—in days not long gone by—to the emolument of the harpies who victimized the visitors to the spot, is now being harnessed to more prosaic work in man's service. Here the civil engineer must study the river and the possibilities as to location; the skill of the mining engineer is required in the design and construction of the tunnel; the hydraulic engineer must investigate the water-power, and, together with the mechanical engineer, must design the 5000 horse-power turbines, some of which have recently been constructed by metallurgical engineers in the service of the great Cramp establishment at Philadelphia; and the electrical engineer must look after the matter from the top of the turbine-shafts, where the generators are to be placed, to the city of Buffalo, which is to be "lighted from the Falls," and to the numerous consumers of power who will be served by this patient giant who has so long waited to be chained.

And what possibilities in the way of revolution of our industrial and economic methods are shadowed forth by this greatest and most dramatic of all instances of the electric transmission of energy! No engineer needs to be reminded that in electricity we have, not a new "power," but simply a means of transmission, rendering a service analogous to that of shafting, of belting, or of water or air in pipes. But electricity bids fair to permit such transmission of energy to great distances as may in the near future enable us to utilize many sources of energy, besides that of water-falls, which have hitherto been almost if not entirely neglected, such as wind-power and the power of tides, currents, and waves; so that it is scarcely too much to suppose that, if the process goes on with sufficient rapidity, we may not only defer indefinitely the exhaustion of our coal-mines and forests, but leave these, as it were, a drug on the market, in the same category with the stage-coach, packet-ship, and canal-boat.

The starting of the turbines of the Niagara Falls Paper Co., on January 25,

may be said to be the first practical application of the power of the falls under the auspices of the Cataract Construction Co. The three turbines, of 1100 horse-power each, were built by R. D. Wood & Co., of Philadelphia, from the designs of their engineer, Mr. Emile Geyelin. They are of the inverted type, in which the water acts upward from below the wheel, so that the weight of the latter serves to counteract the pressure of the 145 feet head under which they work, and thus to diminish the resulting friction.

AN engineering specialty of comparatively recent birth and development is that of what may be called insurance engineering, to which such men as Freeman and Woodbury, of Boston, and Hunking, also from Massachusetts but now of Philadelphia, devote their energies, to the more or less complete exclusion of other matters. The insurance engineer, if we may coin the term, is generally in the service of an association of manufacturers formed for mutual protection against fire, and his study is directed to the determination of those forms of building construction, of storage within buildings, and of fire-extinguishing apparatus, which most effectually prevent the breaking out of fire, or which lead to its speedy and economical extinguishment if once started. And let it not be supposed that this segregation of his activities in a field comparatively limited and somewhat removed from the broad acres of "civil engineering" necessarily deprives the profession at large of his services. The insurance engineer is necessarily a hydraulician, at least, and few more exhaustive and valuable contributions to our stock of knowledge of hydraulics have been made than that embodied in Mr. Freeman's researches into the behavior of fire streams and the flow through nozzles, presented within recent years to the American Society of Civil Engineers.

This branch of engineering, like others, has a literature of its own. We note, for instance, "A Technical Dictionary of Fire Insurance" [1886, 344 p.], and "A Technological Dictionary of Insurance Chemistry" [1890, 407 p.], both by William A. Harris, of the Phœnix Fire Office, London.

LABORING in a nearly related field, the noted French hydraulician, M. H. Bazin, co-laborer with the late and great Darcy, has for years been conducting a most elaborate series of experiments upon the flow of water over the weir, that universally recognized measurer of flow to which hydraulicians of all classes are fain to resort. The experiments are divided into five series, the first two of which are devoted to the investigation of weirs delivering a perfectly detached sheet of water, behind which the air has free access. The first of these two series concerns itself with the determination of the coefficient of flow in vertical weirs, while the second is devoted to the study of inclined weirs and to the investigation of the pressures and velocities within the "nappe," as the falling sheet of water is called. The results of these two series have already been published in the proceedings of the Engineers' Club of Philadelphia. In the third series the distinguished experimenter enters upon the study of cases where the air is prevented from entering behind the nappe. The fourth series will shortly be published in the Annales des Ponts et Chaussées, and the entire work will close with a summary of the results obtained in all the series.

SIR WILLIAM ARROL, having bought the old Hammersmith bridge, at London, intending to use the material for false work at the Forth bridge, found the iron, after sixty-two years of service, as good as new. Pure white lead was at the bottom of the secret. Many of the parts, which were inaccessible, had not been repainted since their erection.

IN more senses than one the question of aerial navigation is "in the air." Its study is no longer confined to a few dreamers, but is eagerly taken up by intelligent and practical engineers, who meet in "world's congresses" to discuss its merits and its latest developments. Early in January a lecture was delivered on this subject before the Franklin Institute, in

Philadelphia. The lecturer was to have been Mr. O. Chanute, the well-known civil engineer, past president of the American Society of Civil Engineers, who has been styled the critical historian of aerial navigation, and whose recent writings form so important a portion of the literature of the subject. Mr. Chanute, however, was prevented by illness from appearing, and his place was taken by Professor A. F. Zahm, of Notre Dame University, Indiana. The lecturer divided the inchoate art of aerial navigation into two broad classes—"aeronautics," or ballooning, and "aviation," or flying, each of which may manifest itself in the "active" or in the "passive" state—and proceeded to review their past and present relations and to attempt a modest glance at the future of the art.

While the aviators or "flyers" (if we may borrow a term from railroad practice) have for a long time been studying the subject, the field of practical operations has, until very recent years, been monopolized by the balloonists; but the last decade, and particularly the last five years, have seen the aviators making wonderful strides, and chiefly in the direction of lightening their motors and machinery, until now they seem nearer than their rivals to the accomplishment of results.

The "passive" balloonists, or those who depend for support upon the buoyancy of their vessels, and for propulsion upon the wind, are compelled to rely chiefly upon the constancy of currents in the upper air, and no less an authority than Professor Hazen assures them that at considerable heights, say above 5000 or 6000 feet, the wind in this vicinity blows steadily from the west.

"Passive" ballooning has rendered good service to meteorology. In France, which, by the way, appears to be the home and nursery of aerial navigation, balloons provided with self-recording apparatus have recently been sent up to altitudes far exceeding any ever reached by aeronauts, and their records have given valuable information respecting the temperature of the upper atmosphere. In one of these experiments it was found that the temperature fell 1° F. for every 165 feet of ascent above the earth's surface, and it was estimated that the absolute zero of temperature (= — 459.4° F.) would be found at a height of a little over sixteen miles. These results are too startling to be accepted without thorough verification, but the experiments are being pushed forward.

"Active" balloonists, like their "passive" brethren, rely upon the buoyancy of gas for their support in the air, but make use of machinery for their propulsion and for steering. The great example of this method of navigation is the French military balloon, "La France," the cigar-shaped vessel 165 feet long, 27.5 feet greatest diameter, with suspended car containing electric motors, which was launched in August, 1884, and which made several trips during that and the next year, proving itself well worthy of the title of the dirigible balloon. It made over fourteen miles per hour. Its designer, Renard, is now at work upon a similar bird-of-war of about double the dimensions of La France. With this greater machine it is believed that it will be possible to travel at the rate of twenty-five miles per hour for twelve consecutive hours.

The "active" aviators propose to lift and support themselves in the air, and to propel themselves through it, by means of machinery in the shape of either flapping wings or of a screw propeller, or of an inclined plane called an aeroplane and urged forward by machinery, preferably of the screw type. The leading experimenters in this line are Maxim, of America, Phillips, of England, and Hargrave, of Australia. Maxim has constructed in England a machine 200 feet long, weighing about 7000 pounds and provided with a compound steam-engine exerting 300 horse-power and capable of carrying 14,000 pounds, including the machine itself.

Phillips's machine is a pigmy in comparison. It weighs but 330 pounds, and its screw, 6 feet in diameter, with 8 feet pitch, exerts a pull of 75 pounds when running 400 revolutions per minute. Its aeroplane, 8 × 22 feet, is formed of slats 1¼ inches wide. It has flown 2000 feet, at a speed of forty miles per hour.

Hargrave's machine is propelled by flapping wings instead of screws. These are to be applied to a "cellular kite," consisting of a pair of compound aeroplanes, designed with a special view to the stability of the machine, one of the most important problems confronting the aviator.

Mr. Hargrave has made a large number of models, all of which have flown successfully. His first models were mere paper toys, actuated by gum bands. The machines which he is now constructing are to be propelled by steam power.

Professor Zahm called attention to the following facts, which, he claimed, were amply proved: 1st, that the power required for flight is now found to be much less than was formerly supposed; 2d, that more than the necessary power can be obtained from such motors as the machines can carry; 3d, that a well-designed flying-machine is most efficient at speeds which are impracticable for a balloon; 4th, that at speeds exceeding 25 miles per hour the flying-machine will carry a greater burden than a balloon with the same expenditure of energy, besides being cheaper to house and to repair; 5th, that flying-machines are most efficient when of moderate sizes, whereas balloons, in order to be efficient, must be enormously bulky; 6th, that the flying-machines now actually in sight, when once they have been perfected, may, without stopping for supplies, execute journeys rivalling those of the most powerful birds, both in distance and in speed.

The lecturer concluded his remarks with a brief reference to the efforts of the "passive aviators," who seek to imitate the movements of a bird in soaring when it moves upward through the air with motionless outstretched wings. Herr Lilienthal, of Berlin (a veritable "flying Dutchman"), has been practicing for three years with a pair of wings thirty feet from tip to tip, and weighing forty pounds. Armed with these ponderous pinions, and selecting a hill sloping toward the wind, Herr Lilienthal runs along its top, springs into the air, and coasts downward upon it some sixty or eighty feet.

If this new pursuit of aerial navigation eventually materializes, in which of our established branches of engineering shall it be classed? The "mechanical" and the "electrical" engineer seem to have all the work to do, and the "civil" engineer (the builder of railroads or of waterworks or of canals) practically nothing, although M. Maxim's machine does stand upon and will start from a railway track. Yet aerial navigation hardly belongs either to mechanical or to electrical engineering. It seems rather destined to form a new branch of civil engineering, especially when we reflect that civil engineers are among its foremost disciples in this and in other countries; but if it continues to advance as it has done in the past five years it will have established its independence before it can be fairly classed as a branch.

The serious efforts of the military engineers in the development of the flying art make it appear probable that aerial navigation may come to be regarded as a branch of military engineering, if, indeed, the funeral obsequies of that eminently respectable but practically defunct profession are not performed before the active and interesting embryo is fairly hatched.

At a meeting of the Austrian Society of Engineers and Architects, held November 18, 1893, Professor George Wellner, of the technical high-school at Brünn, laid before a crowded and enthusiastic audience the first publication of his proposed system of aerial navigation, a system which he claims to be absolutely new. The principle which Professor Wellner proposes to employ is perhaps most briefly expressed in the magnificent compound name which he himself has conferred upon the proposed machine: "Segel-radflugmaschine," which in English we can hardly render more concisely than by the expression flying-machine-with-paddle-wheel-sails. To use the inventor's words, his machine is neither more nor less than a mechanical reproduction of the mechanism of a bird's wing, albeit the professor claims, in some respects, to imitate rather the insect than the bird, and especially in this, that many insects can and do readily remain

fixed in a given position in the air, whereas birds can accomplish this only by an excessive expenditure of work.

Professor Wellner raises and propels his flying-machine by means of the rotation of large wheels. The axes of these wheels, like those of screw propellers, are either coincident or parallel with that of the vessel and the direction of its forward motion, and in the matter of propulsion the action of the wheels is similar to that of a propeller; but in respect to the raising of the machine and keeping it suspended in the air, they differ radically in their action from the screw, and resemble rather the paddle-wheel, with movable floats, for here the floats are so arranged, by means of eccentrics and eccentric-rods, that when at the uppermost and lowermost points of a revolution they are so inclined that the vertical component of their pressure forces the air downward and the machine upward (*vice versa*, of course, when their action is reversed), and when their arms are in the horizontal position the floats exert no tendency to raise or lower the machine. Propulsion is provided for by so inclining the webs used for bracing the floats that they act as elements in the blade of a screw, and thus drive the machine forward.

Drawings were presented, showing a "twin-screw" application of the device. A machine designed to carry from four to eight persons has two wheels (or more properly cylinders) 21 feet in diameter and 63 feet long, and between and below these is suspended a cigar-shaped car 8 feet in diameter and 40 feet long, carrying the motors, the passengers, etc. Each wheel or cylinder has arms or spokes, arranged in eight radial planes and carrying as many floats. The arms, like the axles, are of steel tubing. Steering is accomplished by means of four rudders, which, by being placed at right angles to the path of the vessel, may, the inventor claims, be used to hold the machine steady, without motion forward or backward.

Such a machine, at 135 revolutions per minute, would exert 30 horse-power, would lift 14,000 pounds and would be capable of traveling from 45 to 90 miles per hour. A machine for two persons would require from 30 to 40 horse-power and would cost from $8000 to $12,000.

A small model, with but one wheel and worked by hand, was exhibited, and was run backward so as to exert a downward pressure in addition to its weight, and this pressure was measured by weighing it upon a scale. The current of air through the machine, downward when the machine was run in the normal direction, and *vice versa*, was illustrated by the convenient means of tobacco smoke.

So enthusiastic were the members present that a resolution was unanimously adopted, requesting the board of directors to suggest ways and means for carrying on these experiments; and at the meeting of December 30 it was announced that a fund of $800 had been subscribed and placed at the disposal of a committee appointed to prosecute the work.

The inventor says "these are not empty phantoms—not hazy picturings of the desires or airy machinations, that I am pursuing. I stand upon solid ground. I move forward, step by step, upon a mechanically constructive basis. My whole nature revolts from the phantastic."

THE lay mind finds itself asking what must be the effect of wind velocity upon the practical efficiency of the air-ship or flying-machine, supposing it constructed. A machine that could make 30 miles per hour in a calm, while it would make double that velocity in a 30-mile gale in the same direction, would make no progress at all against a head-wind of the same velocity and would be driven backward 10 miles per hour by a 40-mile head-wind. And even supposing a machine constructed with a speed greater than that of any which it may have to encounter, the enormous differences between its rates of travel with and against the wind must at least militate seriously against the regularity of its traffic.

MINING & METALLURGY

Conducted by Albert Williams, Jr.

REFERRING to the problem of the best method of developing a comparatively flat-dipping lode (say 30°, or a little more, from the horizontal) after the lode has been originally opened by a vertical shaft, a correspondent makes a practical suggestion that may be of value to the many mine managers who are confronted with the same difficulty. As to the old controversy of vertical shaft versus incline, other things being nearly equal, the weight of opinion and experience is, we believe, strongly in favor of the former. As our correspondent says, the argument is all one way. The best practice, in this country at least, always adopts the vertical hoist for important operations, unless adits of reasonable length are, from the lay of the ground, feasible, or unless the dip of the lode or vein carries it into a steep hillside, causing a site for a vertical shaft to be disadvantageously placed. Or, where the amount of water to be handled is unusually heavy, it is considered permissible to run adit tunnels of a length that would otherwise be prohibitory. It is true that there are many mines in the United States, just as there are in the older European districts, which were originally opened by inclines on the dip, because of following down pay ore or coal from the surface and because of lack of means to change the system by erecting proper machinery in a new plant over a vertical shaft, so that an unsatisfactory method has been persevered in perforce. But the case in point is that of an important mine opened by vertical shaft, the shaft having passed through the lode and in its descent rapidly increasing the distance to be crosscut and trammed over, each successive level being longer than the one above it, until the tramming expense becomes inordinate. It is assumed that the ground above and near the point of intersection of lode and shaft has been worked out. The case referred to by our correspondent is a concrete example,—that of a real mine, and one which is quite common. Sometimes it is met by changing the vertical shaft into an incline on the lode, an awkward arrangement as usually devised. The plan suggested by our correspondent is to follow the shaft by an incline, but to cut a pocket underground at the angle point or elbow, into which the skip coming up the incline may dump its rock automatically. From this pocket chutes would lead to and feed the cars to be placed on the cages running in the vertical shaft. In this way there would be no great waste of time or money. A sketch of the proposed arrangement shows a very simple and practicable plan—much better than that of turning the angles on wheels. However, at best the problem is always a puzzling one, and has to be solved independently in each instance, the solution depending upon a variety of considerations which cannot be discussed here, the principal perhaps being the extent and relation of the previous workings.

THE American Iron and Steel Association reports the total make of pig-iron in the United States in 1893 at 7,124,502 long tons, as against 9,157,000 tons in 1892, 8,279,870 tons in 1891, and 9,202,703 tons in 1890. The decrease in 1893 from 1892 was over 22 per cent., the falling off occurring wholly in the second half of the year, the production in the first six months having been larger than in the last half of 1892. Twenty-three States contributed to the total, Pennsylvania leading, with Ohio second, Alabama third, and Illinois fourth. The total number of furnaces in blast at the close of 1893 was 137, with

381 out, or about half as many in blast as at the close of the preceding year. These figures will give some idea of the depression in the iron trade. Since the end of the last calendar year the situation has brightened somewhat, but it is now anything but satisfactory. According to the kind of fuel used, the classification of the pig-iron product in 1893 was: anthracite, 1,347,529 tons; charcoal, 386,789 tons; bituminous, 5,390,184 tons. Of this total, 3,568,598 tons were of the Bessemer grade.

THE *Bulletin of the American Iron and Steel Association* publishes full returns of the production of Bessemer steel ingots, and, with a small exception, of Bessemer steel rails of all weights and sections in the United States in 1893. Under "ingots" are included the products of the few Clapp-Griffiths and Robert Bessemer plants and steel castings, the total being 3,123,524 long tons, against 4,168,485 tons in 1892. The productions of Bessemer steel rails in 1893 was the smallest since 1885, being only 1,036,353 tons.

IN the latest annual report of the secretary of the navy of the United States it is stated that the armor-plate tests last year have in cases exceeded in severity any ever attempted either in the United States or elsewhere; while the results have conclusively demonstrated the desirability of using the Harvey process for the armor of all ships now under construction. The development of nickel-steel armor and the Harvey process were fully described by Mr. R. B. Dashiell in THE ENGINEERING MAGAZINE for September, 1893. The experiments made induced the secretary to order that all the armor already contracted for, and not too far advanced, should be "Harveyized." The report also refers to the noteworthy success of American steel-makers in producing armor-piercing projectiles, and it is said that they are equal, if not superior, to any made abroad.

THE German pig-iron industry, like that of the United States and Great Britain, has suffered in the general business depression. The output for 1893 is estimated at about 4,700,000 metric tons. The decrease from the production of 1892 was not large—about 7000 tons—but prices were much lower, owing to the slackened demand for finished iron and steel.

THE *American Slate Trade Journal* figures the production of slate in the United States in 1893 at $3,578,000 worth, of which $2,780,600 worth was roofing slate. The number of quarries reported is 202, situated in Pennsylvania, New York, Vermont, Maine, and Virginia. In point of quantity the production showed little decrease from 1892, but prices were much lower.

ACCORDING to provisional estimates of the *Engineering and Mining Journal*, the production of zinc in the United States in 1893 was about 74,500 tons (of 2000 lbs.), against 83,619 in 1892.

The same authority states that the output of copper from domestic ores in 1893 exceeded somewhat the production in 1892 (which was reported in the "Mineral Industry" at 325,180 long tons and in "Mineral Resources" at 344,998,679 long tons). The Calumet & Hecla mine, of Michigan, considerably increased its output; while the Anaconda, of Montana, curtailed operations on account of low prices.

The production of lead in the United States in 1893, again quoting from the *Journal's* estimate, was about 150,000 short tons from domestic ores and 58,000 tons from foreign ore and base bullion. The falling off as compared with the production in the preceding year occurred wholly in domestic silver-bearing lead.

NEVADA has fallen behind wofully in the production of the precious metals since the bonanza times. The report of the State controller for the year ending September 30, 1893, just issued, gives the value of the bullion product of that period at only $2,501,169. For the calendar year 1893 the Virginia City *Enterprise* estimates the total for the State at $3,000,000, of which about $800,000 only is cred-

ited to the Comstock lode. This would have been thought a poor showing for one month in the old days.

IT is not generally known that anthracite is mined to a limited extent in the Rocky mountain region. The beds, it is true, are not comparable to those of Pennsylvania, either in size or quality, being locally altered deposits of bituminous coal metamorphosed by the heat of intrusive dikes. A recent discovery of a new deposit has been made near Ouray, Colorado. In 1892 the anthracite product of that State was 62,303 tons, all from Gunnison county.

THE annual report of Wells, Fargo & Co., showing the precious metals produced in 1893 in the States and Territories west of the Missouri river (including $263,968 gold from British Columbia) gives the aggregate production as follows: Gold, $34,202,691; silver, $38,491,521; copper, $23,631,339; lead, $7,756,640; gross result, $104,081,591. The several metals mentioned have been estimated at the following commercial values: Silver, 74 cents per ounce; copper, 10 cents per pound; lead, $3.50 per hundred. Mr. Valentine, president of the company, who collected the statistics, explains that allowance must be made for probable variations from exact figures, by reason of constantly increasing facilities or transporting bullion, ores, and base metals from the mines outside of the express and the difficulty of getting entirely reliable data from private sources. Estimates obtained in this way are liable to be exaggerated.

IN a report of the Pennsylvania coal-waste commission it is stated that the amount of waste is estimated at 317,000,000 tons, representing a money value of about $600,000,000. The president of the Scranton board of trade adds: "We are increasing the amount of waste annually by a volume of 2,000,000 tons, an aggregate of natural substance going to waste unheard of and unparalleled. The culm above ground and the annual increase, if reduced to a gas equivalent, would make a total of 200,000,000,000 cubic feet of gas." He further says "the contemplation of the gas subject in the anthracite coal fields is almost like an Aladdin story." After careful and exhaustive calculation, he figures out that this gas could be produced for less than 2 cents per thousand cubic feet, and he emphasizes this conclusion by adding: "Incredible as these figures may seem, they are certainly approximately true, and will undoubtedly in time be fully verified." Some successful experiments have been made lately in producing a gas from anthracite coal, differing from former water-gas projects. Besides this possible utilization, there is a promising system of burning the culm under boilers in furnaces of special design, already mentioned in these columns. The manufacture of briquettes does not appear to be increasing rapidly, though there is at least one make that is finding a fair market.

AS was to have been expected, a very determined effort has been made by representatives of the coal-mining interests against the adoption of the free bituminous coal clause of the new Wilson tariff bill, which has passed the house and at the date of writing remains to be acted on by the senate. Unquestionably the removal of the present duty (75 cents a ton) would for a time at least adversely affect the coal-producers, especially in Pennsylvania, Maryland, Virginia, West Virginia and Washington. It would, on the other hand, benefit the manufacturers on the seaboard, particularly in New England (where soft coal is not mined and only a little poor anthracite), who would then draw upon Nova Scotia and perhaps England, the foreign coal coming in at low freight rates and occasionally as ballast. Along the great lakes a reciprocal arrangement with Canada would tend to equalize matters. On the Pacific coast British Columbia would become a stronger competitor with Washington for the California and Oregon trade, and imports from New South Wales to San Francisco might be increased. A little Mexican coal would probably reach

Arizona. In the interior a removal of the duty would not greatly alter the present condition for consumers, who would continue to draw upon the nearest coal-fields. There is no general monopoly of the bituminous-coal trade, the sources being too numerous and diverse. In brief, the price of bituminous coal depends on three main factors: the cost of mining (mainly wages), freights, and (along the seaboard and by sympathy to a certain extent inland) the effect of an import duty. To these items might be added the royalty, where the operator does not own the ground worked. On the principle of putting all raw materials on the free list it is only consistent that bituminous coal should be so classed; yet, while it cannot be denied that many consumers would be benefited, the change seriously threatens the coal-mining industry wherever the difference in cost of transportation in favor of domestic fuel will not outweigh the cheaper production of foreign coals.

IMPORTED lead-ores, in the schedule of the Wilson tariff bill, are to be subject to a duty of 15 per cent. ad valorem, unless the value of the silver contents exceeds that of the lead, in which latter case they are to be admitted free. This item has been for years the bone of bitter contention between the interests involved. The clause bears almost wholly upon imports of silver-lead ores from Mexico, little coming into the United States from other sources. The smelters favorably situated for taking the Mexican ores naturally favor low duty or free imports; those at a distance do not. Miners of lead and silver-lead ores in the United States of course desire a protective tariff; while some miners of dry ores requiring lead-ores for the smelting mixture would be benefited by cheap lead ores. Hence the tariff question in this instance is a purely local issue. Lead-ore is certainly one of the rawest of raw materials.

MR. J. S. JEANS, the leading English authority on the subject, in a paper recently read before the British Iron and Trade Association, makes a frank acknowledgment of the supremacy of the United States in iron- and steel-manufacture. The statistics quoted are very striking, and in discussing them Mr. Jeans points out that not only has Great Britain lost its supremacy as the iron-manufacturer of the world, and as the first producer of steel and as the manufacturer of the products of rolling-mills and forges dealing with malleable iron, and as a maker of pig-iron, but, finally, as the principal iron-ore producing country of the world. If, however, the author had laid more stress on the respective exports of iron and steel, a better relative showing could be made for the older country. In the United States it is mainly the immense demand for home consumption caused by the necessities of rapid development, as in railways and machinery, that has brought this great industry to the fore, while thus far we have only made a beginning as a competitor in the world's markets.

AN important strike of lead-ore is reported at Galena, Illinois, in a mine that had been abandoned by an Eastern syndicate which formerly operated it. The find was made by two miners who had faith in the property and persevered in prospecting it. At present prices for lead only exceptionally rich deposits pay for working.

OF forty applications by hydraulic miners in California to be allowed to resume work, made up to the close of January, twenty-four were passed upon favorably by the débris commission and others await further action. It is evident that when impounding works to retain the tailings shall have been constructed in accordance with the plans, a considerable number of hydraulic mines will be placed again upon the active list, thus adding materially to the gold output of California, so long restricted by adverse legislation and judicial decisions.

IN a recent paper on "The Chemist in Foundry Practice" Mr. H. O. Chute, after explaining the causes which led to the divorce of the foundry from the iron-furnace, discusses the problems which the

founder is called upon to solve, and shows how under intelligent technical management tedious and costly experimentation with the cupola may be supplanted by the knowledge derived from chemical analysis. Mr. Chute takes, for example, the case of a cupola mix of six or more irons, containing six varying proportions of six elements, the question being to produce a definite result, and very justly says that the number of combinations which may be made before the right one is found offers a very interesting field for the calculation of the mathematician, but that their contemplation often wearies the founder. Here an analysis of the casting locates the cause of the trouble, if any, and a knowledge of the composition of the irons in the mix enables the offender to be singled out and points the remedy at the same time. Heretofore, Mr. Chute says, the majority of founders have considered that the extent of their business did not warrant the employment of the services of a chemist. The Foundrymen's Association, however, offers an opportunity for mutual aid in this direction by having a laboratory for their special use, where they could always consult with a specialist on the problems constantly arising. The improvement of quality and cheapening of product, with greater precision in method, are the points aimed at, and progressive founders appreciate the extent to which their art will be indebted to chemical knowledge. In this they are merely falling in line with other similar industries, which have found it poor p›licy to rely upon empiric methods when a scientific treatment is within reach.

ONE of the disadvantages of the ordinary beehive coke-oven is the difficulty of getting sufficient heat to the b›ttom of the charge. The lower stratum of coal is either undercoked and the product has to be sold as an inferior grade of coke, or the top of the charge is overburned, causing waste. An improvement which is said to give excellent results is the addition of a horizontal flue from the trunnel head connected with a vertical joint outside the oven and leading down to a series of other horizontal flues at the bottom of the oven by which the hot gases are circulated under the charge and thence out. The effect is reported to be a more uniform grade of coke with a saving in time and of some material.

IRON-ORE is mined in thirteen departments in France, the total number of mines or workings in activity being about sixty. The total production of iron-ore of all kinds is about 2,500,000 tons a year, the average value of which at the place of production is given at 3½ francs.

RECENT experiments in utilizing peat for gas-making have not given satisfactory results; but it is stated that the peat tried was not of the best quality. Any method by which it could be profitably employed on a larger scale would open a practically new industry, the resources for which are enormous in many parts of the world where better fuel is not available.

AN investigation into the gases "inclosed" in coal dust has been made and described by Dr. T. P. Bedson before the British Association. The conclusions reached are that the denser hydrocarbons are more firmly held by the coal substance than the lighter marsh-gas; and that in the working of the coal the reduction to a fine powder, such as coal dust, must, by free exposure to the air, allow ample opportunity for a ready diffusion of the marsh-gas, the denser hydrocarbons being retained by particles of coal.

AN ancient but apparently still successful trick for entrapping the unwary into buying worthless mining stock is to give the latter a name so closely resembling that of some paying and reputable mine that only those who are well informed can tell the difference. This small, mean fraud has been exposed about as often and publicly as the bunco and sawdust games, bnt like these it continues to work. There are always plenty of gudgeons ready to bite at the most palpable shams. During the Leadville excitement a whole flock of stock companies were floated having names closely imitating that of the one *mine* de-

riving its name from that of the district, but varying from it by slight additions or word twists. Now in a new western gold-mining district there is a mine which has made a creditable record for itself by paying small dividends continuously for many months. Its fame has, after the old fashion, been traded upon by another company which has adopted its title, adding the word "consolidated" as a saving distinction — which, however, would escape the notice of any one not familiar with the two properties. In this case a strange, but not unprecedented, accident has occurred. Originally started purely as a stock-selling scheme, the promoters now find themselves in the unexpected position of having a mine on their hands, having really struck ore, so at least it is reported. It would be a curious bit of unpoetic justice if the second property turned out bigger than its namesake, for then its sponsors would feel like kicking themselves for not having adopted a distinctive name of their own. This game of appropriating names of well-known mines has been carried to such an extent that the share certificates have sometimes been printed in close imitation of more valuable stock, the slight differences in title being to all appearance suppressed by being put in letters so small as not to attract notice. A parallel device for misleading innocent investors of small means and less knowledge about mining is to confound common with treasury stock, advertising quotations of the one as for both kinds, whereas there might be all the difference between the two that exists between something and nothing.

A NEW electric safety-lamp, known as the Gauzantes and named after the French electrician, its inventor, is claimed to surpass all previous types of electric safety-lamps in point of small size and lightness. It is thus described by an English journal: "In size the lamp is four inches wide, two inches broad and about eight inches high. Its weight, when fully charged is about three pounds and twelve ounces, and it gives a light of three-fourths candle power. The first cost of construction is only $1.25, and the weekly cost of replenishing the battery is only eleven cents, whilst so little wear and tear do the internal parts undergo that the life of the lamp is reckoned to be five years. The metal which serves as the anode of energy is refined by a new and simple process, and allows a maximum generation of current without fear of rapid polarization, which has up to the present time proved the great obstacle to the employment of the direct source of electricity. The fluid which serves as exciter is a new combination, giving in a single liquid all the properties necessary for the production of a regular and constant current, not only from a dynamic point of view, but also in the reabsorption of the sulphates thereby produced. The new fluid can be manipulated without danger in either preparation or use. The lamp has been tested in Belgium, and the opinion of the introducers was distinctly that the lamp was a good one."

Another improvement in safety-lamps is a modification applicable to the "J. C. N.," Marsaut, or Muessler patterns, enabling them to use with safety, it is said, kerosene or other cheap mineral oil. The attachment is designed to prevent the flame spreading down the wick into the oil-well, where the trimmer works, and includes a nickel-plated reflector for increasing the illuminating power.

FROM time to time the record for deep boring is broken, and now, according to the *Revue Scientifique*, it is held by a bore-hole at Parvschowitz, in western Silesia. The depth is 6568 feet, at which point work has been temporarily suspended, but it is hoped to attain a final depth of 8200 feet. The bore is only 2¾ inches in diameter, as reported, though it is to be presumed that this figure relates to the lower portion only, it being customary in sinking very deep borings to begin with a large diameter, using smaller and smaller bits as the work goes down. It will be noticed that if such a boring were to be started at the bottom of a mine 4000 feet deep, a total depth of over two miles could be explored.

CURRENT TECHNICAL LITERATURE

Conducted by Nelson W. Perry, E. M.

A STANDARD DICTIONARY OF THE ENGLISH LANGUAGE, Prepared by more than Two Hundred Specialists and Other Scholars, Under the Supervision of Isaac K. Funk, D.D. Francis A. March, LL.D., L.H.D., and Daniel S. Gregory, D.D., Editors, and Arthur E. Bostwick, Ph.D., John Denison Champlin, M.A., and Rossiter Johnson, Ph.D., LL.D., Associate Editors. In two volumes. Vol. I—A to L. New York: Funk & Wagnalls Co. [Half Russia. 4to. xx-1060 p. $7.50.]

OF the making of dictionaries there is apparently no end, and indeed it may well be so, since surely a completed language is like a finished city, ready to take its place among the dead, and the activity among the dictionary-makers may be as true an indication of strength and life as is the busy disorder of the growing city in its prime.

It has sometimes been questioned whether there is advantage or detriment in the establishment of an official repository of a language, such as the French Academy, and while we have as yet no such monument as the great work of Littré, the absence of competition has certainly acted to limit the production of such popular and valuable works as the one before us to countries in which any publisher may enter the field, confident that his product must stand or fall on its own merits, without either the help or hindrance of government authority.

To review the work as a whole would be both foreign to the scope of this Magazine and impossible in moderate limits of space, but the sub-title of the Funk & Wagnalls "Standard Dictionary" invites special attention to technical terms, since it is claimed that the work is "designed to give, in complete and accurate statement, in the light of the most recent advances of knowledge, the meaning, orthography, pronunciation, and etymology of all the words and the idiomatic phrases in the speech and literature of the English-speaking peoples."

It is especially gratifying to find that the claims included in this very broad scheme have, on the whole, been fairly well substantiated; for a good, technical dictionary, giving in popular as well as accurate statement the correct meaning of technical terms, has heretofore been sadly lacking, even those which make no claim to include the whole language often failing to give the correct definitions of many terms in the specialty which they profess to cover. To find, then, a general dictionary of the English language in which all the technical terms have been defined by specialists is indeed encouraging, and the popular form in which the work has been done is a strong tribute to the growing interest of the entire people in scientific subjects.

The method adopted combines that of the dictionary with that of the encyclopedia, illustrations being freely used and usually with the scale of reduction given. The value of illustrations appears to great advantage in the case of mechanical subjects, as is perhaps best shown in the subject "Locomotive," under which a line drawing of a "Class O" locomotive engine of the Pennsylvania railroad is given, with nearly a hundred reference lines, giving immediate and accurate information of the various parts. A similar illustration is given to "Lathe," although the drawing is hardly so good, while "Engine" is shown by a small cut, which at least serves the purpose of making the definitions intelligible. These and similar subjects are given very full treatment, the definitions being in many cases accompanied by a brief explanatory text, forming practically a short encyclopedia article, thus greatly increasing the value of the book, especially to non-professional users.

Among the titles which are treated with especial fullness may be mentioned architecture, carpentry, cement, clay, cotton,

color, coin, engine, explosive, foundry, gun, knot, lathe, lock and locomotive. As this first volume only includes titles from A to L, inclusive, many cross-references cannot be compared, but doubtless the second volume will correspond closely in every way with the first.

Among the definitions some exceptions must be taken, and it is especially unfortunate to find among these one which cannot but prolong the task which accurate writers upon mechanical subjects have so long been endeavoring to complete: the removal of the existing confusion in the use of the fundamental terms of mechanics. There are few more common errors, in both popular and practical usage, than the misuse of the term "force" as synonymous with "power," and indeed it is to a misconception of just these terms that so many fallacious attempts are made by half-educated mechanics to produce devices which shall in some mechanical way result in a gain of "power." From the inventor of the latest perpetual motion down to the man who has hit upon a "power-gaining device" which shall make the bicycle "wheels go round" faster up heavy grades without the expenditure of more "force," we find abundant examples of the need of more accurate understanding of the true meaning of these terms.

Turning now to the word "Force," we find it most correctly defined as "any cause that produces, stops, changes, or tends to produce, stop, or change the motion of a body," this being practically Tait's admirable definition. But, unfornately, this is immediately followed in the same sentence by "*mechanical power* as exerted in pulling, pushing, pressing, attracting, or repelling," thus clearly defining *force* as *mechanical power*, and this error is only partially retrieved by the subsequent explanation that force "may be measured in pounds or other units of weight." In the absence of the definition of the term "Power" it is impossible to compare the two definitions, but, turning to "Energy," we find it most tersely defined as "power in active exercise; force in operation," than which nothing better could be desired. In the explanatory text accompanying the definition of "Force," after a clear discussion of the relations of "force" and "energy," the statement is correctly made that "the *energy* possessed by a body is quite another thing from the *force* exerted on it or by it," and yet it is difficult to see the difference between "mechanical power as exerted in pulling, pushing, etc.," and "power in active exercise." Clearly the use of the term "mechanical power" in the definition of force is objectionable and unfortunate.

The definition of "Kinematics" as "a branch of mechanics" is also unfortunate, especially in view of the fact that in the only treatise on the subject worthy of the name, that of Reuleaux, an especial effort is made to show that the subject does not belong to mechanics, its definition being given as "the science of pure mechanism," —also "the science of controlled motion," quite a different thing.

It is gratifying to find the term "Knot," in nautical usage, clearly distinguished from a nautical mile, and this latter use of the term stated to be limited to "landsmen." The only sense in which a knot can properly be conceived as an absolute length is as the distance on the log-line between two consecutive knots or marks, the term knot being properly a *rate of speed* rather than a distance, and always to be used in connection with the element of time.

Under the title "Lock" the term "time-lock" ought to be found, and "combination-lock" given its primary definition as a permutation-lock, instead of giving this place to the combination of two locks acting upon one bolt. The definition of "combination lock" as a "permutation lock," when no definition of the latter term is given at all, is hardly productive of much information to one who is not already informed, and the definition of "Janus-faced lock" as "one in which the key may enter on either side" is altogether too broad, as it would thus include nearly every kind of room-door lock. A "Janus-faced lock" is a form of rim-lock of which both sides of the case are made exactly alike, so that it can be applied to either right- or left-hand doors without change.

Notwithstanding the above points in which greater accuracy should have been given in the definitions, the work is to be regarded as a most valuable addition to the standard list of reference books which every working library should possess, and the fact that, with the one exception above noted, the only points for adverse criticism are of minor importance, is evidence of the fact that the Standard Dictionary is a mine of valuable material, not only in general literature but also in the remote details of special technology.

HENRY HARRISON SUPLEE.

INVENTIONS, RESEARCHES, AND WRITINGS OF NIKOLA Tesla, with Special Reference to his Work in Polyphase Currents and High Potential Lighting. By Thomas Commerford Martin, Editor *The Electrical Engineer;* Past President American Institute Electrical Engineers. Portrait of Mr. Tesla and numerous other illustrations. New York: *The Electrical Engineer.* [Cloth. 8vo. 496 p. $4.]

NIKOLA TESLA'S fame among the electricians and the laity alike has been almost unparalleled, and he and his work have been the subject of more newspaper comment during the past two or three years than is usual even with men who among their confreres have stood equally high. There has been a charm about his experiments with high frequencies and potentials, looking towards the accomplishment of the ideal light without heat that has captivated the laity and thrown into the shade in their estimation his equally important and more practical work with which electricians have been long familiar. Nor have his experiments with the high potentials and frequencies been less interesting to electricians, for they saw in them new avenues of investigation leading no one could or can tell where, but in all probability to results of the grandest import, if pursued to their legitimate end.

Mr. Tesla first called public attention to his experiments with alternate currents of very high frequency and their application to methods of artificial illumination in a lecture before the American Institute of Electrical Engineers at Columbia College on May 20, 1891. These attracted such wide attention among scientific men abroad that he was induced to repeat the lecture with amplifications in London on February 3, 1892. His reception in London by the leading physicists of England was an ovation such as had never before been accorded to a scientific man.

A third lecture, delivered in abstract before the Franklin Institute of Philadelphia last spring, and in full a few days later before the National Electric Light Convention at St. Louis, completes his own expositions of his discoveries in this line, and a fourth lecture, delivered before a limited number of invited guests, including many of the leading savants of the world, during the International Electrical Congress at Chicago, may be said to complete the list of his appearances before public audiences. The last lecture, which was on the subject of mechanical and electrical oscillators—a subject entirely distinct from the other three—was never reported in full, but is given in Mr. Martin's book in substance. The other three lectures are given at length, with ample illustrations.

But while Mr. Tesla has not appeared much in public, he has been an indefatigable worker along original lines. The descriptions of his discoveries have from time to time appeared in print, but they have become so scattered as to render their collection into convenient shape very difficult, and this is a part of the task which the author has assumed.

Then, again, there is much of Mr. Tesla's work that has been so misunderstood as to lead to confusion among those who have tried to follow him. To explain this work in simple language that even the layman might understand was the remaining and greater part of the task which Mr. Martin undertook, and which he has fulfilled in a most admirable manner.

The work is divided primarily into four parts, and these again into chapters. Part I is introduced by a chapter which is chiefly biographical, and then follow twenty-three chapters devoted to polyphase currents and their applications. Part II is devoted to the Tesla effects with high frequencies and high potential currents. In this are given verbatim the New York lecture (53 pages), the London lecture (96 pages),

and the Philadelphia and St. Louis lecture (80 pages). Part III is devoted to miscellaneous inventious and writings and Part IV, in the form of an appendix, describes in two chapters Mr. Tesla's personal exhibit at the World's Fair and the Tesla mechanical and electrical oscillators which were the subject of his World's Fair lecture.

The work is one that will be welcomed by those who are attempting to keep abreast of advanced thought and research, no less than by those who from a non-professional point of view take an intelligent interest in the advancement of science.

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ELECTRIC WAVES, BEING RESEARCHES ON THE PROPAGATION of Electric Action with Finite Velocity through Space. By Dr. Herrick Hertz, Professor of Physics in the University of Bonn. Authorized English Translation by D. E. Jones, B. Sc., with a Preface by Lord Kelvin, LL.D., D.C.L. New York: Macmillan. [Cloth. 8vo. 278 p.]

THIS work, which for the first time brings together the numerous papers published by Dr. Hertz in "Wiedemann's Annalen" on the subject of his magnificent experimental researches in demonstration of Maxwell's electro-magnetic theory of light, is a most welcome addition to electrical literature. The translator, in explanation of the appearance of this work, says that "the publishers of 'Wiedemann's Annalen,' being unable to comply with the numerous applications made for copies of Professor Hertz's researches, invited him to prepare his papers for publication in a collected form. To recast or thoroughly revise them would have been a serious undertaking, and researches are most easily understood when described from the standpoint from which they are undertaken. It was therefore felt best to reprint the separate papers in the form in which they were originally published; but Professor Hertz fortunately decided to supplement the papers by explanatory notes, and to write an introduction, in which he describes the manner in which the investigations were undertaken, and also describes their bearing upon electrical theory and the criticisms to which they have been subjected. The collected researches were published early last year [1892] under the title '*Untersuchungen liber die Aüsbreitung der Electrischen Kraft.*' The book now presented to the English reader is a translation of the German original, with only one or two slight alterations in the notes, and a change, suggested by Lord Kelvin, in the title. I would scarcely have undertaken the translation if I had not been able to rely upon the supervision and kind assistance which Professor Hertz has most freely given, and for which my heartiest thanks are due. I have had the advantage of revising the proofs with him in Bonn, and now trust that no serious error will have escaped notice."

Professor M. I. Pieperi, in an admirable series of articles published in *The Electrical World*, inspired by the recent death of Professor Hertz, estimates his place in botany and the part he played in the development of science so happily that we feel constrained to quote. After having referred to the conflict which existed prior to Faraday between the idea of direct action at a distance, which at that time was the prevailing hypothesis, and the idea of a transferance of action by means of a continuous medium, he says that the latter theory only seemed to introduce additional difficulties into the mathematical analysis of electrical phenomena without offering any reward for this additional labor. "Necessarily so, because experimental science at that time had no wealth to offer for this additional exertion, and it had no simple, plausible theory to substitute in place of the 'direct action at a distance hypothesis.' *It was Faraday who added this wealth and made some vague promises of the reward; it was Maxwell who first discovered the hidden treasures of this wealth, and in most glowing colors described the reward that we would gain by abandoning our old scientific faith in the 'direct action at a distance hypothesis'* and embracing the new faith of Faraday, *and it was Hertz who first convinced us all that Faraday's and Maxwell's promises, though apparently too good to be true, were even more than true.*'

In the case of all great achievements it is interesting to trace back to the germ that gave rise to such great results. Pro-

fessor Hertz has saved us the trouble of threading this labyrinth by stating in his introduction what he regards as the starting-point of his special work in this line. In commenting upon this, Lord Kelvin says in his preface: "It is interesting to know, as Hertz explains in his introduction—and it is very important in respect to the experimental demonstration of magnetic waves to which he was led—that he began his electric researches in a problem happily put before him thirteen years ago by Professor von Helmholtz, of which the object was to find by experiment some relation between electro-magnetic forces and dielectric polarization of insulators, without, in the first place, any idea of discovering a progressive propagation of those forces through space."

It will be pleasing to Americans to note that Lord Kelvin, as Professor Oliver Lodge had done before him, gives credit to Joseph Henry for having more nearly approached an experimental demonstration of electro-magnetic waves than any one before him.

In conclusion Lord Kelvin says: "During the fifty-six years which have passed since Faraday first offended physical mathematicians with his curved lines of force, many workers and many thinkers have helped to build up the nineteenth-century school of *plenum*, one ether for light, heat, electricity, magnetism; and the German and English volumes containing Hertz's electrical papers, given to the world in the last decade of the century, will be a permanent monument of the splendid consummation now realized."

The character of the book has already been sufficiently described as a reprint, with some additions by Professor Hertz, of his various papers in the order in which they appeared in "Wiedemann's Annalen." It is well gotten up, with many illustrations, principally diagrammatic, which help out the descriptive portions of the text. But it has no vestige of an index other than an index to names, nor has it even a table of contents. It is unfortunate that these essentials to a book's usefulness should have been entirely neglected.

HELICAL GEARS: A PRACTICAL TREATISE. By a Foreman Pattern-maker, author of Lockwood's Dictionary of Mechanical Engineering Terms. Illustrated. New York: Macmillan & Co. [Cloth. 123 p. $2.]

THE design of helical gears is a subject of the greatest importance to the engineer, and yet, strange to say, it is one that has been very much neglected. We are inclined to believe with the author that a very large proportion (he says 50 per cent.) of the so-called helical gears are made quite incorrectly. He begins with Dr. Hook's gear, invented in 1674, as an illustration of the transitional form from the ordinary to the helical gears, and then by logical and graphical methods leads the reader up to the true helical gear, based on its fundamental relationships with the true screw or helical. This little book, which forms one of the Specialists' Series, is intended as a text-book for students in technical schools and should, we think, find favor and usefulness in that field. The author's diction is singularly clear and free from involved descriptions, and is practical rather than theoretical. The illustrations, however, are not first-rate. In the development by graphical methods of such complicated forms as are here dealt with the multiplication of lines becomes necessarily very great, and any cheapening of the processes of illustration is to be deplored, as adding unnecessarily to the difficulties of the student in following the text.

THE TINSMITHS' PATTERN MANUAL. Patterns for Tinsmiths' Work. By Joe K. Little, C. E. Chicago: *American Artisan* Press. [Cloth. 8vo. 237 p.]

THIS is an attempt in an elementary way to supplant the empirical rules for developing tin and other sheet-metal forms usual among artisans by more general geometrical principles. We fear, however, that the author has dipped too deeply into descriptive geometry for the audience for which he writes.

THE·TECHNICAL·INDEX

A CATALOGUE OF LEADING ARTICLES PUBLISHED CURRENTLY IN THE TECHNICAL JOURNALS OF THE UNITED STATES AND GREAT BRITAIN.

THIS publication has been aptly described as "the greatest step that has been taken in recent years towards systematizing work" for the engineer, the architect, the electrician, the railway manager, and the business man. The list of publications regularly indexed will show that it covers a world-wide range of the best technical literature, and all the articles are so conveniently classified under general headings that within a few minutes an active man can learn of everything that has been published during the month in relation to his special lines of investigation. In short, it is to the practical man just what Poole's celebrated index to periodicals has long been to the literary worker, but with this essential difference,—namely, that in addition to indicating *just where* leading articles have been published, *we undertake to supply copies of the articles themselves*. The unparalleled convenience and economy of this double service can readily be appreciated.

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[In the body of the index only the initials of the journals quoted are given, and these can be readily identified by the following list of periodicals. Other abbreviations are: Ill=Illustrated. w=words.]

THE AMERICAN PRESS.

A.....Arena. *m.* $5 per year. Boston.
AA.....American Architect. *w.* $6. Boston.
An A A...Annals of Am. Academy of Political and Social Science. *b-m.* $6. Philadelphia.
A An.... American Analyst. *f.* $1. New York.
A Ar.... American Artisan. *w.* $2. Chicago.
A & B....Architecture and Building. *w.* $6. N. Y.
A C J....Am. Chem. Journal. *b-m.* $4. Baltimore.
A E .....Architectural Era. *m.* $3. New York.
A E R J..Am. Eng. and Railroad Journal. *m.* $3. N.Y.
A G.....Am. Geologist. *m.* $3.50. Minneapolis.
A G L J..Am. Gas Light Journal. *w.* $3. New York.
A H.....Annals of Hygiene. *m.* $2. Phila.
A J Phar.Am. Journal of Pharmacy. *m.* $3. Phila.
A J R A..Jour. R'y. Appliances. *m.* $2. New York.
A M.....American Machinist. *w.* $3. New York.
A M & I W.Am. Man. and Iron World. $4. Pittsburg.
Am A....American Agriculturist. *m.* $1.50. N.Y.
Am G....American Gardening. *m.* $1. New York.
Am S....American Shipbuilder. *w.* $2. New York.
A & N J..Army and Navy Journal. *w.* $6. New York.
A & N R..Army and Navy Register. *w.* $3. Wash'ton.
A Rev....Architectural Review. *s-q.* $5. Boston.
A S .....Age of Steel. *w.* $3. St. Louis.
B B.....Brick Builder. *m.* $2.50. Boston.
B C.....Boston Commonwealth. *w.* $2.50. Boston.
B & D...Builder and Dec. *m.* $2. Minneapolis.
B I S....Bul. Am. Iron and St. Asso. *w.* $4. Phila.
B J C....Boston Jour. of Commerce. *w.* $3. Boston.
B & W...Builder and Woodworker. *m.* $1. N. Y.
C.....Compass. *m.* $1. New York.
C A.....Calif. Architect. *m.* $3. San Francisco.
Can A...Canadian Architect. *m.* $2. Toronto.
C & B...Carpentry and Building. *m.* $1. New York.
C E .....Colliery Engineer. *m.* $2. Scranton, Pa.
C E N...Canadian Elec. News. *m.* $1. Toronto.
C Eng....Canadian Engineer. *m.* $1. Montreal.
Ch.....Chautauquan. *m.* $2. Meadville, Pa.
C M.....Century Magazine. *m.* $4. New York.
Cos.....Cosmopolitan. *m.* $1.50. New York.
D E.....Domestic Engineering. *m.* $1. Chicago.
E A.....Electrical Age. *w.* $3. New York.
E E N Y..Electrical Engineer. *w.* $3. New York.
E I.....Electrical Industries. *m.* $3. Chicago.
E M.....Engineering Mechanics. *m.* $2. Phila.
E Mag...Engineering Magazine. *m.* $3. New York.
E M J....Eng. and Mining Journal. *w.* $5. N.Y.
E N.....Engineering News. *w.* $5. New York.
Eng .....Engineer. *s-m.* $2. New York.
E N Y....Electricity. *w.* $2.50. New York.
E R.....Engineering Record. *w.* $5. New York.
E R N Y..Electrical Review. *w.* $3. New York.
E & R ...Elec. and Railroading. *m.* $1. Boston.
E S W P...Proc. Eng. So. of W. Pa. *m.* $7. Pittsburg.
E W.....Electrical World. *w.* $3. New York.
F .....Forum. *m.* $5. New York.
F D.....The Foundry. *m.* $1. Detroit.
F W.....Fire and Water. *w.* $3. New York.
G & F....Garden and Forest. *w.* $4. New York.
G G M...Goldthwaite's Geograp. Mag. *m.* $2. N. Y.

G R.....Good Roads. *m.* $2. New York.
I A.....Inland Architect. *m.* $5. Chicago.
I Age....Inventive Age. *s-m.* $1. Washington.
Ir Age..Iron Age. *w.* $4.50. New York.
I I G.....Iron Ind. Gazette. *m.* $1.50. Buffalo.
I R W...India Rubber World. *m.* $3. New York.
I S F.....Industry. *m.* $2. San Francisco.
I T R....Iron Trade Review. *w.* $3. Cleveland.
J A.... ..Journal of Architecture. *m.* $2. Phila.
J A C S..Jour. Am. Chem. So. *m.* $5. Easton.
J A E S. Jour. Assoc. Eng. Soc. *m.* $3. Chicago.
J F I.....Jour. Franklin Institute. *m* $5. Phila.
J M S I..Jour. Milit. Service In. *b-m.* $4. New York.
J N E W.Jour. N. E. Waterw. As. *q.* $2. New London.
J P E.....Jour. Polit. Economy. *q.* $3. Chicago.
J U S A. Jour. U. S. Artillery. *q.* $2.50. Ft. Monroe.
L E.....Locomotive Engineering. *m.* $2. N. Y.
L Mag...Lippincott's Magazine. *m.* $3. Phila.
M & B...Manufacturer and Builder. *m.* $1.50. N. Y.
M & El...Mech. and Electrician. *w.* $2. St. Louis.
Met W...Metal Worker. *w.* $2. N. Y.
M G.....Manufacturer's Gazette. *w.* $2.50. Boston.
Min.....Minerals. *m.* $1. N. Y.
Min. R...The Mining Review. *w.* $2. Denver.
M I T....Mining Industry. *w.* $3. Denver.
M N.....Mechanical News. *s-m.* $1.50. New York.
M R.....Manufacturer's Record. *w.* $4. Baltimore.
M R C...Marine Review. *w.* $2. Cleveland, O.
M Rec....The Marine Record. *w.* $2. Cleveland.
M S P....Min. and Sci. Press. *w.* $3. San Francisco.
M S R....Mining and Sci. Review. *w.* $2. Denver.
N A R...North American Review. *m.* $5. N. Y.
N B .....National Builder. *m.* $3. Chicago.
N C B...National Car Builder. *m.* $2. New York.
N P R...Nat. Popular Review. *m.* $2.50. Chicago.
N W.....Nowest. Architect. *m.* $3. Minneapolis.
O P D R..Oil, Paint and Drug Reporter. *w.* $6. N.Y.
P.....Paving. *m.* $2. Indianapolis.
P A.....Progressive Age. *s-m.* $3. New York.
P D.. ...Painting and Decorating. *m.* $1. Phila.
P E.....Practical Electricity. *f.* $2. Boston.
P S.....Power-Steam. *m.* $1. N. Y.
P S M....Popular Science Monthly. *m.* $5. N. Y.
R A.....Railway Age. *w.* $4. Chicago.
R C J....Railroad Car Journal. *m.* $1. New York.
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S M.....ScientificMachinist.*s-m.*$1.50. Cleveland,O.
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S P.....Sanitary Plumber. *s-m.* $1. New York.
S R G....Street Railway Gazette. *w.* $3. Chicago.
S R J....Street Railway Journal. *m.* $4. New York.
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S R R.. .Street Railway Review. *m.* $2. Chicago.
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EngL... Engineer. *w.* 36*s.* London.
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E Rev....Engineering Review. *m.* 7*s.* London.
E R L.....Electrical Review. *w.* 21*s.* 8*d.* London.
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R R L...The Railway Review. *w.* London.
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S L.....Steamship. *m.* Leith, Scotland.
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15307. Nomenclature, Symbols, and Notation. E. Hospitalier (E W–Aug. 26.) 1000 w.

15308. Electromagnetic and Electrostatic Hysteresis. Charles Proteus Steinmetz (E W–Aug. 26.) 2000 w.

15310 A New Hot Wire Voltmeter. Ill. A. S. Kimball (E W–Aug. 26.) 2000 w.

15311. Delegates to the International Electrical Congress, Chicago, Aug. 21, 1893. Ill. (E W–Aug. 26.) 10000 w.

15313. Through Electricity. Building. Ill. (E W–Aug. 26.) 18500 w.

15324. An Interview with W. H. Preece. J. A. M. (E R N Y–Aug. 26.) 1500 w.

15329. Electricity at Wesleyan University. Ill. (E E N Y–Aug. 23.) 1100 w.

15349. Opening of the Electrical Congress, Aug. 21, 1893 (W E–Aug. 26.) 7600 w.

15350. Determining the Efficiency of Transformers. G. Claude (W E–Aug. 26.) 900 w.

15378. Carbon and Its Uses in Electrical Engineering. Clarence M. Barber (E N Y–Aug. 23.) 3400 w.

*15410. Electrical Congresses and Electrical Units. Editorial (El–Aug. 18.) 1700 w.

*15413. Note on the Comparative Effectiveness of Different Types of Lightning Guards. Ill. E. Massin (El–Aug. 18.) 2000 w.

*15445. Electric Heating. S. B. Jenkins (M W–Aug. 18.) 2700 w.

15471. Mr. Tesla's Lecture on Mechanical and Electrical Oscillators (E E N Y–Aug. 30.) 1650 w.

15474. Motor Meters. Frank P. Cox (E W–Sept. 2.) 1600 w.

15475. Proceedings of the International Electrical Congress. Ill. (E W–Sept. 2.) 13000 w.

15477. On the Transmission of Electric Signals through Space. Ill. W. H. Preece (E W–Sept. 2.) 4000 w.

15478. London Electrical Engineering Laboratories. Andrew Jamieson (E W–Sept. 2.) 4400 w.

15592. Multiphase Motors and the Transmission of Power. Ill. (E W–Sept. 9.) 5400 w.

15593. Iron for Transformers. J. A. Ewing (E W–Sept. 9.) 700 w.

15594. On Direct Current Dynamos of Very High Potential. F. B. Crocker (E W–Sept. 9.) 1600 w.

*15626. Dynamo Shielding. Ill. W. H. M. Christie (El–Aug. 25.) 950 w.

15629. An Electric Race Course. Ill. (E R N Y–Sept. 9.) 1400 w.

15632. The Physiological Effects of Currents of High Frequency. H. Lewis Jones (A G L J–Sept. 4.) 900 w.

*15645. Westinghouse Armatures. Ill. (E E L–Aug. 25.) 1600 w.

*15646. Geometrical Proof of the Three-Ammeter Method of Measuring Power. Ill. F. Bedell and A. C. Crehore (E E L–Aug. 25.) 300 w.

*15656. Artificial Diamonds Obtained by the Action of the Electric Arc on Hydro-Carbons. Editorial (E L–Aug. 25.) 500 w.

15686. A Novel Method of Transforming Alternating into Continuous Currents. Charles Pollak (E N Y–Sept. 6.) 1500 w.

15687. On a Method of Governing an Electric Motor for Chronographic Purposes. A. G. Webster (E N Y–Sept. 6.) 1000 w.

15690. Electroplating with Copper. J. D. Darling (ScA–Sept. 9.) 1000 w.

15725 Exhibit of Tesla's Polyphase System at the World's Fair. C. F. Scott (W E–Sept. 9) 2000 w.

15727. A Pair of Electrostatic Voltmeters. H. S. Carhart (W E–Sept. 9.) 1000 w.

Serials.

14797. Quartz Fibres and Rods: How to Make and How to Use Them. Edwin F. Northrup (E W–Began Aug. 5—Ended Aug. 19—2 parts—15 cts. each).

15125. Galvanic Batteries. Ill. Cosmos (I C B–Began Aug. 4—Ended Aug. 18—3 parts—30 cts. each).

15269. Practical Measurement of Alternating Electric Currents. Ill. J. A. Fleming (J S A–Began Aug. 11—3 parts to date—30 cts. each).

15431. Means of Diminishing Sparking in Continuous-Current Dynamos. Ill. W. C. Rechnieroski (E E L–Began Aug. 18—2 parts to date—30 cts. each).

15476. Judging the Electrical Exhibits at the World's Fair. Hermann S. Hering (E W–Began Sept. 2—2 parts to date—15 cts. each).

ELECTRIC LIGHTING.

15141. The Largest Search Light in the World. Ill. (E W–Aug 19.) 1000 w.

15170. Suggestions Toward Improving the Earnings of Unprofitable Central Stations. J. H. Vail (E E N Y–Aug. 16.) 4000 w.

15300 Incandescent Lamp Tests (E W–Aug. 26.) 950 w.

15328. The "New Beacon" Non-Infringing Incandescent Lamp. Ill. (E E N Y–Aug. 23.) 1800 w.

*15408. The Smythe-Payne System of Fireproof Wiring. Ill. (El–Aug. 18.) 1000 w.

*15412. Lord Kelvin's New Electricity Meters. Ill. Andrew W. Meikle (El–Aug. 18.) 1900 w.

15470. A New Incandescent Arc Light. Ill. L. B. Marks (E E N Y–Aug. 30.) 3000 w.

15473. Underground Wires for Electric Lighting and Power Distribution. D. C. Jackson (E E N Y–Aug. 30.) 1000 w.

15484. The Great German Search Lights at the World's Columbian Exposition. Ill. (ScA–Sept. 2.) 1100 w.

*15664. Artificial Sources of Light. C. Feldmann (G W–Aug. 26.) 2000 w.

15726. Portable Electric Light Plants. Ill. M. A. Hess (W E–Sept. 9.) 800 w.

Serials.

6709. Electric Light and Power. Arthur F. Guy (E E L–Began Sept. 9, 1892—28 parts to date—30 cts. each).

9531. Suggestions for Metering Devices. Ill. S. D. Mott (E W–Began Jan. 14—6 parts to date—15 cts. each).

13548. Arc Lighting. E. Tremlett Carter—(E R L–Began June 2—9 parts to date—30 cts. each).

14433. The Incandescent Lamp, Its Manufacture and Use. Ill. Gilbert S. Ram (El–Began July 7—8 parts to date—30 cts. each).

14897. On the Electric Light of Lighthouses. André Blondel (E E L–Began July 23—Ended Aug. 11—3 parts—30 cts. each).

15312. Arc Lamps at the World's Fair. Ill. (E W–Began Aug. 26—1 part to date—15 cts).

GAS ENGINEERING.

15052. Toronto's Gas Consumption, with Description of New Holder Nearing Completion (A G L J–Aug. 14.) 1500 w.

*15068. On the Mixture and Stratification of Gases. W. Leybold (G W–Aug. 5.) 900 w.

*15069. The Principles of the Production of Illuminating Gas from Liquid Hydrocarbons. William Young (G W–Aug. 5.) 3300 w.

*15102. The Combustion Heat of Coal Gas and Its Relation to the Illuminating Power. M. Aiguitton (C G–Aug. 4.) 750 w.

*15202. Automatic Prepayment Meters (J G L–Aug. 8.) 2200 w.

*15203. Notes on the Prepayment Meter, with Discussion. G. Keillor (J G L–Aug. 8.) 3500 w.

*15204. The Production of Illuminating Gas from Liquid Hydrocarbons by the Peebles Process. Ill. A. Bell (J G L–Aug. 8.) 2500 w.

*15389. Differential Prices. Norton H. Humphrys (J G L–Aug. 15.) 2200 w.

*15390. Cooking by Gas. J. Ballantyne (J G L–Aug. 15.) 3700 w.

15442. The Gas Engine as Applied to Electric Light Work. George A. Farwell (A G L J–Aug. 28.) 2000 w.

15443. The Action of Ammonia Gas upon Molybdenyl Chloride. Edgar F. Smith and Victor Lehner (A G L J–Aug. 28.) 1600 w.

*15546. On the Heat Value (Calorimetrically Determined) of Lighting Gas. Ill. B. H. Thwaite (J G L–Aug. 22.) 700 w.

*15547. Description of a New Oil Gas Works Erected at the Inchicove Works, Dublin, with Discussion. C. B. Outon (J G L–Aug. 22.) 3000 w.

*15548. The History and Development of Cooking by Gas, with Discussion. A. Main (J G L–Aug. 22.) 3100 w.

*15698. Automatic Appliances for Small Gas Works. Ill. Gilbert Little (J G L–Aug. 29.) 2200 w.

Serials.

14900. Gaseous Fuel and Its Production. George Ritchie (I C T–Began July 28—Ended Aug. 25—3 parts—30 cts. each).

15534. Purifiers for Small Works (P A–Began Sept. 1—1 part to date—15 cts).

15535. The Development of Ignition Devices for Gas Engines. Ill. G. Lieckfeld (P A–Began Sept. 1—1 part to date—15 cts).

HYDRAULICS.

15016. Some Questions Concerning the Filtration of Water. W. Kuemmel (E N–Aug. 10.) 1800 w.

15017. An Evaporative Surface Condenser. Ill. James H. Fitts (E N–Aug. 10.) 1000 w.

15041. Turbine Water Wheels.—The Attributes Which Good Ones Should Have (B J C–Aug. 12.) 750 w.

15194. The Basin Creek Dam for the Water-Works of Butte, Mont. Ill. (E N–Aug. 17.) 900 w.

15197. The Reservoir Break at Portland, Me. (E N–Aug. 17.) 2000 w.

†15200. Opening of Savantwadi Water Works (I E–July 15.) 1700 w.

15211. Purifying Croton Water by Electricity (W E–Aug. 19.) 1200 w.

*15295. The Kosheshah Escape, Middle Egypt. Ill. (E–Aug. 11.) 2500 w.

15335. California Methods of Irrigation (M S P–Aug. 19) 1000 w.

†15375. Description of the Sawantwadi Water-Works. Ill. J. E. Whiting (I E–July 22.) 1200 w.

15380. Prehistoric Irrigation in Arizona (Sc A–Aug. 26.) 600 w.

15404. The Worthington Engine at Concord, N. H. (E R–Aug. 26.) 2000 w.

*15448. Extension of the Waterworks for Douglas, Isle of Man. Ill. (Eng L–Aug. 18.) 300 w.

15492. The Catastrophe at Schneidemuhl. Ill. (Sc A S–Sept. 2.) 650 w.

15520. History of the Haverhill Aqueduct Company, 1801-1892 (E N–Aug. 31.) 3000 w.

15521. An Arched Pipe Bridge and 34 and 30 in. By-Pass Connection: Citizens' Water Company, Denver, Colo. Ill. W. F. Allen (E N–Aug. 31.) 500 w.

†15531. The Elements of Tank Construction (I E–July 29.) 2500 w.

†15562. Artesian Wells. Oscar C. S. Carter (J F I–Sept.) 2800 w.

*15582. The Designing of a Water-Works System. E. A. Rudiger (P–Sept.) 850 w.

*15647. Water Supply Works in Italy (I & I–Aug. 25.) 800 w.

*15660. Girard Turbines at Orizaba, Mexico (Eng L–Aug. 25.) 1200 w.

*15661. Some Modern Developments in Hydraulic Machinery. Ill. (Eng L–Aug. 25.) 1200 w.

*15705. Notes on Artesian Water and the Effect of Irrigation on Subsurface Water in the San Joaquin Valley, California. Ill. C. E. Grunsky (I S F–Sept.) 6200 w.

15733. Incidents in Water Supply Tests. I. T. Fanning (E R–Sept. 9.) 3000 w.

15734. A Legal Decision on Meter Rates (E R–Sept. 9.) 1650 w.

INDUSTRIAL CHEMISTRY.

†15021. Recent Science. Prince Kropotkine (N C–Aug.) 8500 w.

15168. New Cellulose Derivatives and Their Industrial Applications. C. F. Cross, E. J. Bevan, and C. Beadle (Sc A S–Aug. 19.) 4000 w.

†15180. Recent Methods in Fertilizer Analysis. Edwin J. Haley (J A C S–April.) 1200 w.

15301. Artificial Ice in Massachusetts (E R–Aug. 19.) 1000 w.

15382. Arsenic Works on the Tamar. Ill. S. Baring-Gould (Sc A S–Aug. 26.) 1500 w.

15398. Ancient Chemical Apparatus and Laboratories. H. Carrington Bolton (M I T–Aug. 24.) 1200 w.

15543. Nitrogen and Its Uses (M G–Sept. 2.) 1000 w.

15551. Chemistry in Cane Sugar Manufacture. J. T. Crawley (Sc–Aug. 25.) 700 w.

15573. A Cooler for Sulphuric Acid. Ill. A. D. Ledoux (M R–Sept. 1.) 1800 w.

15574. Some Cotton-Oil Problems for Chemists. C. B. Warrand (M R–Sept. 1.) 950 w.

INDUSTRIAL SOCIOLOGY.

*14987. The Real Currency of Commerce. George S. Coe (E Mag–Oct.) 3000 w.

*14992. The Effect of Subsidies on Shipping. Thomas Rhodes (E Mag–Oct.) 3000 w.

†15022. How Long, O Lord, How Long?—Miseries of the East End Needle-women. W. H. Wilkins (N C–Aug.) 4000 w.

†15023. The Associated Life. Walter Besant (C R–Aug.) 3500 w.

†15024. The British Farmer and the Deluge of Foreign Produce. James Long (F R–Aug.) 4800 w.

†15025. The Poor of the World: India, Japan and the United States. Samuel A. Barnett (F R–Aug.) 7500 w.

†15134. Modern Industrial Warfare. John W. Cunliffe (W R–Aug.) 2800 w.

15227. Negro Labor (B J C–Aug. 19.) 600 w.

15236. Reducing Wages. W. H. Wakeman (M G–Aug. 19.) 900 w.

15241. Labor and Learners. A. B. Salom (I I G–Aug.) 1800 w.

15381. The Labor Syndicates and the Labor Exchanges. Ill. (Sc A S–Aug. 26.) 3400 w.

*15388. The Triumph of Free Labor in Australia (J G L–Aug. 15.) 2600 w.

15391. The Battle for the Boys (S P–Aug. 15.) 3600 w.

*15438. Trade Guilds and Trade Unions. Editorial (I & I–Aug. 18.) 1200 w.

15506. Unemployed Labor. Editorial (Ir Age–Aug. 31.) 1000 w.

*15545. The Dawn of a New Unionism (J G L–Aug. 22.) 2000 w.

†15723. The Teachings of the Labor Commission. C. H. d'E. Leppington (C R–Sept.) 7300 w.

Serials.

14903. St. Mary's Chapel, Edinburgh. James Colston (I C B–Began July 28—Ended Aug. 4—2 parts—30 cts. each).

LANDSCAPE ENGINEERING.

15459. The General Design of the Columbian Exposition (G & F–Aug. 30.) 3000 w.

15695. Tender Plants in Public Parks (G & F–Sept. 6.) 1800 w.

15696. The Front Esplanade of the Horticultural Building. L. H. Bailey (G & F–Sept. 7.) 1500 w.

MARINE ENGINEERING.

*14993. Science and Sport in Model Yachting. Ill. F. R. Burton (E Mag–Oct.) 3000 w.

*15056. The New Type of Cargo Steamer (Tr–Aug. 4.) 900 w.

*15075. The White Star Line at the Chicago Exposition. Ill. (E–Aug. 4.) 450 w.

*15079. Shipowners and Shipbuilders. A. Denny (E–Aug. 4.) 3000 w.

*15095. Some Maritime Questions. Editorial (Eng L–Aug. 4.) 1400 w.

*15097. The First Transatlantic Steamer (Eng L–Aug. 4.) 850 w.

15159. Deep Water Harbors.—The Harbor Deepening at Brunswick, Ga., by the Use of Dynamite (T–Aug. 15.) 750 w.

15163. The Port of Bizerte. Ill. (Sc A S–Aug. 19.) 1800 w.

15167. The Departure of Dr. Nansen's Arctic Expedition. Ill. (Sc A S–Aug. 19.) 1000 w.

15187. Mammoth Steamboat Launched.—The Priscilla (Sea–Aug. 17.) 1600 w.

15188. Vanderbilt's Steam Yacht, Valiant (Sea–Aug. 17.) 1500 w.

15231. A Merchant Marine Bureau (M Rec–Aug. 17.) 1000 w.

15232. A New Method of Correcting the Course of a Ship, for Change of Variation. H. C. Pearson (M Rec–Aug. 17.) 1400 w.

15233. Arctic Expeditions (M Rec–Aug. 17.) 800 w.

15234. Experimental Tanks. Ill. (M R C–Aug. 17.) 2200 w.

*15257. Hydrographical Surveys. Editorial (Eng L–Aug. 11.) 1500 w.

*15259. Woodwork in Modern Ships.—Carpenters v. Joiners (Eng L–Aug. 11.) 800 w.

*15293. Lee's Hydro-Pneumatic Ashes Ejector. Ill. (I & I–Aug. 11.) 850 w.

15342. Australia to London via Superior (M Rec–Aug. 24.) 1000 w.

15368. Government Inspection of Merchant

Steamers and the Influence Thereon of the Rules of the Registration Societies. E. Platt Stratton (Sea–Aug. 24.) 4500 w.

*15446. The Motive Power of Small Vessels (Eng L–Aug. 18.) 2800 w.

15480. U. S. Revenue Steamer "William Windom." Ill. (A M–Aug. 31.) 800 w.

15511. Polar Probabilities of 1894. A. W. Greely (N A R–Sept.) 3800 w.

15516. Correction of Magnetic Course for Swing of Compass Card. H. C. Pearson (Sea–Aug. 31.) 2200 w.

15517. The Fastest Vessel Afloat.—The Feiseen (Sea–Aug. 31.) 600 w.

15527. Laying Down a Vessel. Ill. C. H. Simonds (Am S–Aug. 31.) 900 w.

15533. Making Row Boats of Sheet Metal. Ill. (C & B–Sept.) 2000 w.

*15613. A Year's Losses at Sea (Tr–Aug. 25.) 950 w.

*15634. The Tides of the Bay of Fundy. Ill. Gustav Kobbé (Sc M–Sept.) 4800 w.

*15641. Lighting and Light Dues in the Red Sea (E–Aug. 25.) 950 w.

15665. On Combination of Cranks with Their Shafts; of Driving Shafts of Marine Engines, and of Their Liability to Fracture. Charles H. Haswell (Eng–Sept. 2.) 2000 w.

15667. Torpedo Boats for U. S. S. Maine and Texas. Ill. (M R C–Aug. 31.) 1800 w.

15688. The Cunard Steamer "Lucania." Ill. (Am S–Sept. 7.) 850 w.

15708. Startling Facts Regarding Our Marine. Editorial (Sea–Sept. 7.) 2300 w.

15716. Gen. Poe Answers Mr. Wisner (M R C–Sept. 7.) 1200 w.

Serials.

12250. Capt. Alex. McDougall's Patents. Ill. (M R C–Began April 20—13 parts to date—15 cts. each).

13449. Our Flag at Sea. William W. Bates (Sea–Began June 8—Ended Aug. 10—7 parts—15 cts. each).

14875. "The Atlantic Ferry."—A Review of the Origin and Progress of the Trans-atlantic Steam Services. A. J. Maginnis (Inv–Began July 29—Ended Aug. 5—2 parts—30 cts. each).

14893. Steam Communication with the Continent, Past and Present. A. E. Seaton (E–Began July 28—Ended Aug. 4—2 parts—30 cts. each).

14951. Early Lake Navigators (M R C–Began Aug. 3—2 parts to date—15 cts. each).

15077. The Extension of the Port of Dunkirk. M. Joly (E–Began Aug. 4—Ended Aug. 11—2 parts—30 cts. each).

15277. The First Steam Screw Propeller Boats to Navigate the Waters of Any Country. Francis B. Stevens (Eng–Began Aug. 19—2 parts to date—15 cts. each).

MECHANICAL ENGINEERING.

*14989. Machine-Shop Instruction in Schools. Joseph Torrey (E Mag–Oct.) 3000 w.

15059. The Collection of Dust Produced in Work-shops. R. Kahfahl (E R–Aug. 12.) 700 w.

*15082. Machine Keys. Ill. J. Richards (M W–Aug. 4.) 1100 w.

15156. The Initial Construction of Machinery.—What We Learn in the Light of Experience. Leicester Allen (T–Aug. 15.) 1700 w.

15169. Materials of Engineering. W. H. Booth (A M–Aug. 17.) 2000 w.

15174. The History of the Art of Interchangeable Construction in Mechanism (B I S–Aug. 16.) 2600 w.

15184. Machinery Does It. Leicester Allen (I Age–Aug.) 1100 w.

15185. Making Grindstones. Ill. (S M–Aug. 15.) 700 w.

*15258. Refined Method of Manufacturing Screws. Ill. (Eng L–Aug. 11.) 1500 w.

15263. A Giant Telescope—The Mechanical Features of the Yerkes Instrument (B C–Aug. 19.) 900 w.

*15280. Taxation of Machinery Abroad (I & S–Aug. 12.) 1400 w.

15286. American Tools in China (M N–Aug. 15.) 850 w.

15287. Molding Cutters (M N–Aug. 15.) 1200 w.

15345. The Great Improvements Made in Spinning Mules the Past Fifteen Years. Oblivion (B J C–Aug. 26.) 1400 w.

15373. Improvements in the Art of Cable Making. Ill. Emil Guilleaume (Ir Age–Aug. 24.) 2000 w.

15384. Annular and Differential Gearing. S. W. Balch (A M–Aug. 24.) 3600 w.

*15387. The Machinist. Ill. Fred J. Miller (Sc M–Sept.) 10500 w.

*15435. The Taxation of Factories in France (E–Aug. 18.) 1700 w.

*15450. The Institution of Mechanical Engineers. Editorial (Eng L–Aug. 18.) 1800 w.

15455. An Automatic Grain Weighing Machine. Ill. (R R–Aug. 26.) 800 w.

15487. Moving of a Shed at Rouen. Ill. (Sc A S–Sept. 2.) 1200 w.

15488. Weicher's Fiber Extracting Machine (Sc A S–Sept. 2.) 1500 w.

15519. An Inclined Passenger Elevator. Ill. (I Age–Sept.) 350 w.

15555. A Coal Calorimeter.—Finding the Heat Value of Coals (B J C–Sept. 2.) 800 w.

*15575. Engineer Ferris and His Wheel. Ill. (R of R–Sept.) 7000 w.

15589. Power Plant of the World's Columbian Exposition. Charles F. Foster (E R–Sept. 2.) 2000 w.

*15623. Tests and Specifications of Stay Bolts. Ill. (P Eng–Aug. 25.) 3000 w.

15682. Imperfection in Emery Wheels (M N–Sept. 1.) 450 w.

15693. The Mechanics of Bank Safe Burglary. Ill. H. A. (A M–Sept. 7.) 2300 w.

Serials.

12142. On Machine Designing. William H. Atherton (M W-Began April 7—Ended Aug. 4—9 parts—30 cts. each).

14879. The Battle of the Typewriters (Inv.-Began July 29—2 parts to date—30 cts. each).

15088. Possible and Impossible Economics in the Utilization of Energy. Alex. B. W. Kennedy (El-Began Aug. 4—Ended Aug. 18—3 parts—30 cts. each).

15182. Notes on American Clock-Making. F. A. Seely (I Age-Began Aug.—2 parts to date—15 cts. each).

METALLURGY.

15030. The Microstructure of Steel. Ill. Albert Sauveur (E M J-Aug. 12.) 1800 w.

15040. Slag No Longer Wasted—It is Now Being Converted into a Valuable Fertilizer (B J C-Aug. 12.) 400 w.

*15049. Recent Developments in the Cleveland Iron and Steel Industries, with Discussion. Jeremiah Head (I & I-Aug. 4.) 11600 w.

†15177. The Electrolytic Separation of the Metals of the Second Group. Samuel C. Schmucker (J A C S-April.) 4000 w.

†15178. The Action of Gases upon Metallic Molybdenum and Tungsten. Edgar F. Smith and Vickers Oberholtzer (J A C S-April.) 1800 w.

†15179. A New Method for the Quantitative Determination of Carbon in Iron and Steel. Ill. Otto Petterson and August Smett (J A C S-April.) 1300 w.

15190. The Effect of Punching and Shearing Structural Steel (E N-Aug. 17.) 3000 w.

15206. Studying the Steel Question in Birmingham (M R-Aug. 18.) 800 w.

15239. The Action of the Smelters of Silver Ores (E M J-Aug. 19.) 1600 w.

15242. German Iron Making (I I G-Aug.) 2000 w.

15327. An Analcite Copper Bowlder from the Keweenaw Range, Michigan. E. O. Hovey (Sc-Aug. 18.) 500 w.

15356. Steel in Its Relation to Birmingham. W. B. Phillips (M R-Aug. 25.) 2700 w.

*15365. Coke (A J R A-Aug.) 800 w.

*15418. Treating Magnetic Ore for Tin Extraction. Walter J. May (C G-Aug. 18.) 800 w.

*15422. The Future of the Cleveland Pig Iron Trade (C G-Aug. 18.) 1300 w.

15458. Tempering Steel—Nature—Necessity—Methods. B. F. Spalding (A S-Aug. 26.) 2200 w.

15482. Letter to the Hon. William L. Wilson from the American Iron and Steel Association (B I S-Aug. 30.) 6500 w.

15507. The Regulation of Temperature in the Converter. John E. Fry (I Age-Aug. 31.) 2200 w.

*15605. An Improved Internal Form of Blast Furnace (C G-Aug. 25.) 800 w.

*15620. The Extraction of Antimony by Electrical Methods (E R L-Aug. 25.) 700 w.

*15680. The Treatment of Sulphides. F. H. Molesworth (A M S-Aug. 5.) 2600 w.

15692. The Founding of Statues, with a Review of the Art as Practised by the Ancients, and up to the Present Time. S. Bolland (A M-Sept. 7.) 3200 w.

15702. Automatic Valve Gear for Blowing Engines. Ill. James C. Brooks (Ir Age-Sept. 7.) 1600 w.

15709. A New Metallurgy., Paper by Admiral Selwyn Describing his "Zymean Process of Ore Reduction"—with Review by Editor (M S P-Sept. 2.) 4800 w.

Serials.

12714. The Practical Zinc Worker. Ill. W. J. Eden Crane (Pl D-Began May 1—4 parts to date—30 cts. each).

12897. Iron and Steel at the World's Columbian Exposition. E. C. Potter (Ir Age-Began May 18—5 parts to date—15 cts. each).

13880. Aluminium—Its Production, Properties, and Uses (Inv-Began June 17—11 parts to date—30 cts. each).

14188. The Specific Heats of the Metals. Joseph W. Richards (J F I-Began July—Ended Sept.—3 parts—45 cts. each).

14915. Washed Coal for Coking. Walter J. May (A M & I W-Began Aug. 4—Ended Aug. 18—2 parts—15 cts. each).

14974. Rod-Rolling Mills and Their Development in America. Ill. Fred. H. Daniels (Ir Age-Began Aug. 10—Ended Aug. 31—3 parts—15 cts. each).

15006. The Mechanical Concentration of Ores. J. J. East (A M S-Began June 24—4 parts to date—30 cts. each).

15147. Studies in Gold-Milling. J. A. Edman (M S P-Began Aug. 12—2 parts to date—15 cts. each).

15181. Aluminum. R. L. Packard (J A C S-Began April—1 part to date—45 cts).

15339. The Microstructure of Ingot Iron in Cast Ingots. Ill. A. Martens (E M J-Began Aug. 26—2 parts to date—15 cts. each).

15374. The Open-Hearth Process. H. H. Campbell (Ir Age—Began Aug. 24—2 parts to date—15 cts. each).

15444. Practical Hints on the Milling Machine and Its Accessories. Ill. (M W-Began Aug. 18—1 part to date—30 cts).

15584. Wet Gravity Separation of Iron Ores, etc. Walter J. May (A M & I W-Began Sept. 1—1 part to date—15 cts).

MILITARY ENGINEERING.

†15026. The Needs of the Navy. Thomas Symonds (F R-Aug.) 3500 w.

†15027. The Loss of the Victoria. G. Phipps Hornby (F R-Aug.) 3000 w.

*15053. The Steam Navy of England (Tr-Aug. 4) 2000 w.

*15055. The Longitudinal Bulkhead (Tr-Aug. 4.) 900 w.

*15098. The Naval Manœuvres (Eng L-Aug. 4.) 1200 w.

†15135. The Colony of Gibraltar. W. Fraser Rae (W R-Aug.) 5500 w.

15172. Firing Guns at Night by the Aid of the Search Light. Ill. Max Loewenthal (E E N Y-Aug. 16.) 500 w.

*15254. The Naval Manœuvres (Eng L-Aug. 11.) 1400 w.

15260. The Krupp Exhibit at Chicago. Ill. (A & N J-Aug. 19.) 4800 w.

*15296. The Naval Manœuvres. Editorial (E-Aug. 11.) 2300 w.

*15298. H. M. S. "Theseus" (E-Aug. 11.) 2000 w.

†15371. Federal and Confederate Pensions Contrasted. M. B. Morton (F-Sept.) 2800 w.

15379. Nasmyth's Torpedo Boat of 1853. Ill. (Sc A-Aug. 26.) 1600 w.

*15434. Our Engineering Navy. Editorial (E-Aug. 18.) 2500 w.

†15461. Recruiting and Desertion. H. L. Abbot (J M S I-Sept.) 1300 w.

†15462. The Army Organization, Best Applied to a Republican Form of Government, Which Will Insure an Effective Force. E. L. Zalinski (J M S I-Sept.) 17500 w.

†15463. Small Arms Firing. Charles H. Muir (J M S I-Sept.) 2800 w.

†15464. The Bear, the Lion, and the Porcupine. Charles H. Clark (J M S I-Sept.) 7800 w.

†15465. Practice vs. Theory in Army Training. E. H. Plummer (J M S I-Sept.) 3200 w.

†15467. Changes and Progress in Military Matters. Th. v. Jarotzky (J M S I-Sept.) 14500 w.

†15469. The Artillery in 1870-71, from a General Army Point of View. J. F. Maurice (J M S I-Sept.) 10200 w.

15485. The New U. S. S. Detroit. Ill. (Sc A-Sept. 2.) 700 w.

15486. Societies for Cannon Practice. Ill. (Sc A S-Sept. 2.) 900 w.

*15503. War Time Reminiscences. — Captured by Confederate Cavalry. James H. Hevey (L E-Sept.) 1500 w.

†15510. England and France in Siam.—An English View.—George N. Curzon. A French View.—Madame Juliette Adam (N A R-Sept.) 7000 w.

*15578. The Miracle of the Maid of Orleans. Ill. (R of R-Sept.) 7500 w.

15681. High Speed War Ships (M N-Sept. 1.) 1000 w.

Serials.

10738. The Development of American Armor Plate. Ill. F. Lynwood Garrison (M-Began Feb. 15—5 parts to date—30 cts. each).

13956. Military Criticism and Modern Tactics. G. F. R. Henderson (J M S I-Began July—2 parts to date—45 cts. each).

15393. Sheathed and Unsheathed Ships. Philip Hitchborn (Am S-Began Aug. 24—3 parts to date—15 cts. each).

15452. Lessons from the Naval Manœuvres (Eng L-Began Aug. 18—2 parts to date—30 cts. each).

MINING.

*15011. Broken Hill Proprietary Mine.—The Surface Works (A M S-July 8.) 1800 w.

15012. Working Drift Mines. Ill. (M S P-Aug. 5.) 650 w.

*15067. The Coal Strike (G W-Aug. 5.) 1300 w.

*15100. The Montrambert Colliery (France). Ill. (C G-Aug. 4.) 3500 w.

*15101. Wasted Coal. Walter J. May (C G-Aug. 4.) 1000 w.

*15107. The Shaw Gas Testing Machine.—The Detection of Explosive and Other Deleterious Gases in the Air of Coal Mines. Joseph R. Wilson (C E-Aug.) 3800 w.

*15108. Choke Damp Effects and Their Prevention.—The Possibilities of the Newly Discovered Liquefaction of Oxygen in Saving Life. W. H. Booth (C E-Aug.) 700 w.

*15112. Flushing Culm.—A Novel Plan of Conveying Culm into Old Workings to Support the Roof. Ill. (C E-Aug.) 500 w.

*15115. The Filling System of Mining Ores. Ill. M. C. Ihlseng (C E-Aug.) 900 w.

*15116. Prospecting for Placer Gold. Ill. A. C. Lakes (C E-Aug.) 1400 w.

*15117. The Bituminous Mine Law of Pennsylvania.—A Criticism of Those Portions Pertaining to Mine Maps and Duties of Superintendents. "Don." (C E-Aug.) 1800 w.

*15124. Origin of the Bendigo Saddle Reefs, with a Criticism. Ill. (A M S-July 15.) 3000 w.

15146. Application for License to Mine by Hydraulic Method (M S P-Aug. 12.) 1100 w.

15157. Fire Damp in Coal Mines.—How It Is Produced and How It Can Be Avoided (T-Aug. 15.) 1300 w.

15160. Mica Mining in Alabama (T-Aug. 15.) 1200 w.

15162. Mica (Sc A-Aug. 19.) 850 w.

15166. New Fire Damp Indicators. Ill. (Sc A S-Aug. 19.) 1750 w.

15189. Appliances for Mine Ventilation. Ill. Richard O. Jones (I T R-Aug. 10.) 900 w.

15222. Burmese Tin Mines (Met W-Aug. 19.) 600 w.

15230. A Pleasant and Profitable Collecting Trip. Elmer Benge (Min-July-Aug.) 800 w.

15240. The Victor Mine, Cripple Creek, Col. Ill. Edward Skewes and Henry J. Eder (E M J-Aug. 19.) 1200 w.

*15248. How "A Bleak Grass Field" Became a Colliery (G E M-Aug. 10.) 1500 w.

15262. The Manufacture of Salt. H. E. Freeman (B C-Aug. 19.) 1600 w.

*15265. Lost Mines. Albert Williams, Jr. (Ch-Sept.) 3600 w.

15279. Diamonds (Eng-Aug. 19.) 700 w.

*15281. The Soap Stone Industry in China (I & S-Aug. 12.) 700 w.

*15285. The Middlesbrough Salt Industry. Richard Grigg (C G-Aug. 11.) 2000 w.

†15323. Prehistoric Jasper Mines in the Lehigh Hills. Ill. H. C. Mercer (P S M-Sept.) 3300 w.

15336. Traits of the Mine Mule (M S P-Aug. 19.) 900 w.

15337. The Gold Strike in Western Australia. E. D. Peters, Jr. (E M J-Aug. 26.) 1400 w.

15338. The Detection and Measurement of Fire Damp in Mines. Ill. G. Chesneau (E M J-Aug. 26.) 4800 w.

15340. The Facts About the Chapin Mine. S. (I T R-Aug. 24.) 1200 w.

15392. Activity in Placer Mining. Ill. (Min R-Aug. 17.) 800 w.

*15402. Belgian Mining and Miners. R. W. D. (I & S-Aug. 19.) 1500 w.

*15417. Extraction of Shale Oils in France and Scotland. M. G. Chesneau (C G-Aug. 18.) 3200 w.

*15419. Firedamp in the Anzin Mines (C G-Aug. 18.) 750 w.

*15420. About Coals (C G-Aug. 18.) 900 w.

*15427. An Improved Miner's Lamp. M. Adolphe Demuere (I C T-Aug. 18.) 1000 w.

*15439. The Coal Strike and Its Effect on Railways and Shipping (Tr-Aug. 18.) 1200 w.

*15449. The Coal Strike. Editorial (Eng L-Aug. 18.) 1800 w.

15483. The Tin Mines of Maliwun (Sc A-Sept. 2.) 550 w.

15493. The Genesis of Petroleum and Asphalt in California. Ill. A. S. Cooper (Sc A S-Sept. 2.) 5000 w.

†15509. A Woman in the African Diggings. Ill. Annie Russell (C M-Sept.) 3000 w.

15524. Electricity in Mining. F. O. Blackwell (E N-Aug. 31.) 3000 w.

*15550. The Crisis in the Coal Trade (J G L-Aug. 22.) 2500 w.

15569. Report on the Bendigo Gold Field. T. A. Rickard (E M J-Sept. 2.) 1800 w.

15585. The Sulphur Industry in Sicily (O P D R-Sept. 4.) 4500 w.

*15603. The Valdonne Colliery, France. Ill. M. L. Valla (C G-Aug. 25.) 4800 w.

*15604. The Ayrshire Coalfield M. E. (C G-Aug. 25.) 1700 w.

*15606. Reports of the Great Western Colliery Accident (C G-Aug. 25.) 3000 w.

*15639. The Coal War in South Wales. Editorial (E-Aug. 25.) 2000 w.

15669. Small-Sized Anthracite as Fuel (R M M-Sept.) 1100 w.

15701. Gold Mining in the South.—Difficulties that Have Intervened (T-Sept. 1.) 1300 w.

15719. The Origin of Gold. Philip Lake (Sc-Sept. 1.) 650 w.

Serials.

9459. Manufacture of Coke. Ill. J. Fulton (C E-Began Jan.—8 parts to date—30 cts. each).

11282. Mine Ventilation Made Easy. W. Fairley (C E-Began March—6 parts to date—30 cts. each).

11801. Information to Aid in the Search for Gold and Silver. Ill. Arthur C. Lakes (C E-Began April—5 parts to date—30 cts. each).

12450. The Coal Fields of Canada. William Hamilton Merritt (C E-Began May—4 parts to date—30 cts. each).

12815. The Use of Safe Explosives in Coal Mines. E. Gilpin, Jr. (C G-Began May 5—2 parts to date—30 cts. each).

13410. West Australia Mineral Fields (A M S—Began April 22—8 parts to date—30 cts. each).

14334. Pocket Mining. Alex. Quartz (M S P-Began July 8—5 parts to date—15 cts. each).

14923. Coal-Cutting by Machinery. J. William Chubb (P Eng-Began July 28—2 parts to date—30 cts. each).

15099. The Canadian Nickel Mines (Min W-Began Aug. 5—2 parts to date—30 cts. each).

15113. Friction of Air in Mines. Ill. D. Murgue (C E-Began Aug.—1 part to date—30 cts).

15229. The Minerals of Mexico. Joseph H. Hunt (Min-Began July-August—1 part to date—15 cts).

15284. Comparative Tests with Grisontite and Other Explosives. Ill. Prof. Macquet (C G-Began Aug. 11—Ended Aug. 18—2 parts—30 cts. each).

15609. Lost Mines. Albert Williams, Jr. (Min R-Began Aug. 31—1 part to date—15 cts).

15678. The Broken Hill Proprietary Report. Annual Statement (A M S-Began July 22—Ended July 29—2 parts—30 cts. each).

RAILROADING.

15032. The Harlem River Four-Track Drawbridge. Ill. (R G-Aug. 11.) 2200 w.

15033. Surveys for Railroad Location. F. A. Gelbcke (R G-Aug. 11.) 1300 w.

15034. The Block System on Railroads of Light Traffic. Editorial (R G-Aug. 11.) 1600 w.

15035. Complaining Shippers and Their Treatment in England (R G-Aug. 11.) 1200 w.

15070. The Problem of the Pay Roll. Editorial (R A-Aug. 11.) 1000 w.

15071. Abolish Unnecessary Trains. Editorial (R A-Aug. 11.) 900 w.

15072. A Southern California Railway Station. Santa Fé Station at Los Angeles. Ill. (R A-Aug. 11.) 450 w.

15074. Standard Locomotive Tests (R A-Aug. 11.) 3000 w.

15083. Plan to Avoid Grade Crossings in Chicago. Ill. Plan of Millard J. Scott (S R G-Aug. 12.) 400 w.

*15094. Birriz Viaduct—Costa Rica Railway. Ill. (Eng L-Aug. 4.) 900 w.

15127. The Protection of Private Rights and Interests in Connection with Railway Manage-

ment and Operation. Edward P. Ripley (R R–Aug. 12.) 3800 w.

15128. Freight Cars on Royal Prussian Railways. Ill. (R R–Aug. 12.) 2200 w.

15129. An Old Time Card and Ticket. Ill. (R R–Aug. 12.) 300 w.

15130. The Extravagance of Outside Agencies. Editorial (R R–Aug. 12.) 900 w.

15131. The Development of the Compound Locomotive. A. von Borries (R R–Aug. 12.) 3000 w.

†15136. Canada and the Canadian Pacific Railway. J. Castell Hopkins (W R–Aug.) 5800 w.

15140. Storage Battery and Underground Conduit Electric Railways (E W–Aug. 19.) 1200 w.

15142. Ventilation of Passenger Cars. Hygiene (R C J–Aug.) 700 w.

15143. Handling of Air Brakes. F. H. Cooldge and Robert E. Libbey (R C J–Aug.) 3500 w.

15144. Draft Springs. George W. Morris (R C J–Aug.) 2000 w.

15148. Repairing a Train Wreck (M S P–Aug. 12.) 2000 w.

*15149. St. Louis Street Car Ambulance. Ill. (S R R–Aug.) 500 w.

*15150. Siemens' Multiphase Railway Motors (S R R–Aug.) 1000 w.

*15151. Boys Stealing Rides on Cars.—How Can It Be Stopped? (S R R–Aug.) 900 w.

*15152. The Matlock Cable Tramway. Ill. (S R R–Aug.) 2000 w.

*15154. The Pike's Peak Cog Railroad. Ill. (S R R–Aug.) 350 w.

15183. The Brott System of Electric Elevated Railways. Ill. (I Age–Aug.) 800 w.

15192. The Am. Soc. C. E. Standard Rail Sections. Ill. (E N–Aug. 17.) 2200 w.

†15198. "Linking Up" of Indian Railways on the Standard Gauge. Ill. "Two Hundred" (I E–July 15.) 700 w.

15212. Lowering the Grade of the Brooklyn Elevated Railroad on Myrtle Avenue. Ill. (R G–Aug. 18.) 1500 w.

15213. The Car Service Associations—Their Objects and Work (R G–Aug. 18) 1500 w.

15214. The Ramsey-Weir Electrical Interlocking Apparatus. Ill. (R G–Aug. 18.) 2000 w.

15215. Starting Valves of the Baldwin Locomotive Works. Ill. (R G–Aug. 18.) 1200 w.

15243. Shut Out the Canadian Roads (I I G –Aug.) 1900 w.

*15255. The Kinta Valley Railway and the Parak Tin Mines. Ill. (Eng L–Aug. 11.) 1800 w.

*15274. Siam: Its Trade, Shipping and Railways (Tr–Aug. 11.) 1800 w.

15314. Transportation in New York. M. L. Fox (S R G–Aug. 19.) 1800 w.

15315. Statutory Regulation of Transportation and Its Results. A. G. Safford (R R–Aug. 19.) 3500 w.

15317. Sunday Railroad Work (R R–Aug. 19.) 1600 w.

15318. Publicity in Railway Affairs. Editorial (R R–Aug. 19.) 900 w.

15319. The Relation of Railway Signaling to Train Accidents. W. W. Salmon (R R–Aug. 19.) 3000 w.

15320. The Railway Problem. Editorial (A S–Aug. 19.) 700 w.

15362. A Freight Wreck on the Big Four. Ill. (E N–Aug. 24.) 800 w.

*15364. The Illinois Central Railroad Company's Chicago Improvements. Ill. (A J R A–Aug.) 2700 w.

*15367. Bonnefond Valve Motion of the New Passenger Engines in the State Railways of France. Ill. (A J R A–Aug.) 1800 w.

*15396. Underground Railways in London. Editorial (E L–Aug. 18.) 800 w.

15397. A Notable Week's Run of the "Greater Britain." Ill. (R A–Aug. 25.) 600 w.

15405. Standard Live Loads for Railway Bridges.—Letter from J. A. L. Waddell (E R–Aug. 26) 1800 w.

15423. Tests of the Locomotive at the Laboratory at Purdue University. Ill. (R G–Aug. 25.) 3000 w.

15424. Reinforced Brakes. Editorial (R G –Aug. 25.) 1000 w.

15425. A Sketch of European and American Railroad Signaling (R G–Aug. 25.) 1800 w.

*15441. The Fastest Train in the World (Tr–Aug. 18.) 1350 w.

*15447. Dublin, Wicklow, and Wexford Railway.—Westland Row Bridge. Ill. (Eng. L–Aug. 18.) 1700 w.

15456. Car Service as Between Railroads. Editorial (R R–Aug. 26.) 900 w.

15457. Government Ownership of Railroads. A. C. Weaver (R R–Aug. 26.) 2500 w.

15489. The Atmospheric Railway. Ill. (Sc A S–Sept. 2.) 800 w.

15494. Noonan Track Construction Experiments (S R G–Aug. 26.) 3800 w.

*15495. The Railroads of the United States (L E–Sept.) 800 w.

*15496. Railroad Coppersmithing. John Fuller, Sr. (L E–Sept.) 1500 w.

*15497. Schemes for Reducing Compression. Editorial. (L E–Sept.) 1100 w.

*15498. Hot-Boxes. Editorial (L E–Sept.) 550 w.

*15499. A Failure of an Apprentice Experiment. Sam Short (L E–Sept.) 1000 w.

*15500. Quartering Driving Wheels. Ill. George E. Wentworth (L E–Sept.) 1000 w.

*15501. Handling the Air Brake. George Ellis (L E–Sept.) 1000 w.

*15502. New Air-Brake Pressure Regulator. Ill. (L E–Sept.) 750 w.

15525. The Standard Rail Sections. Ill.

Report of Committee and Editorial (R G-Sept. 1.) 2300 w.

†15529. A Proposal to Connect Ceylon with India by Railway (I E-July 29.) 1000 w.

†15536. The New Cable Plant of the Baltimore City Passenger Railway Company. Ill. (S R J-Sept.) 1200 w.

†15537. A Vestibule Street Car Train. Ill. (S R J-Sept.) 750 w.

†15538. The Toronto Railway Company. Ill. (S R J-Sept.) 3000 w.

†15539. The Telephone in Street Railway Service. C. K. Durbin (S R J-Sept.) 1500 w.

†15540. The Intramural Railway. Ill. (S R J-Sept.) 1300 w.

*15563. The Bork Construction of Locomotive Boiler. Ill. (A E R J-Sept.) 5800 w.

*15565. Tests of Metallic Ties on the Belgian State Railways. Ill. (A E R J-Sept.) 3600 w.

*15567. The Fastenings of Rails to Wooden Ties. Jules Michel (A E R J-Sept.) 2800 w.

15595. Railway Tariffs. James L. Cowles (R R-Sept. 2.) 2200 w.

15596. Japanese Railways (R R-Sept. 2.) 900 w.

15597. The Depreciation in Quality of Our Steel Rails. Hunter M'Donald (R R-Sept. 2.) 1800 w.

15598. Flagmen vs. Block Signal. H. S. Haines (R A-Sept. 1.) 2000 w.

15599. Street Railway Mail Service. John B. Harlow (S R G-Sept. 2.) 850 w.

*15602. Railway Travelling and Railway Coaches, Past and Present. Ill. (E Rev-Aug. 21.) 900 w.

*15610. The Railway Year in Great Britain and the United States (Tr-Aug. 25.) 1500 w.

*15612. Irish Harbors and Light Railways (Tr-Aug. 25.) 1000 w.

*15614. The City and South London Railway. Ill. (R W-Aug.) 3800 w.

*15615. The Rack Railway at Bellevue. Ill. (R W-Aug.) 800 w.

*15617. Round the World in Forty Days. Puck, Jr. (R W-Aug.) 950 w.

*15637. Wire Rope Haulage. Ill. (E-Aug. 25.) 2200 w.

*15642. British Railway Dividends (E-Aug. 25.) 1000 w.

*15662. A Remarkable Engine—The Greater Britain. Ill. Charles Rous-Marten (Eng L-Aug. 25.) 3400 w.

15668. The Electric Signals and the Electric Street Railways (R M M-Sept.) 700 w.

15670. Setting the Valves of the Old Variable Cut-off Locomotives (R M M-Sept.) 1000 w.

*15671. Setting Eccentrics before Wheels are under Engine. Ill. George K. Wentworth (N C B-Sept.) 2200 w.

†15684. Points and Crossings in Use on the East Coast Railway. Ill. F. J. E. S. (I E-Aug. 5.) 3000 w.

15710. Track Exhibits at the World's Columbian Exposition (E N-Sept. 7.) 5600 w.

15712. The New Work of the Rapid Transit Commission. Editorial (E N-Sept. 7.) 1000 w.

15713. The Last Great Bridge Disaster. Editorial (E N-Sept. 7.) 2000 w.

15718. Railroad Signaling. Ill. Reginald Gordon (Sc-Sept. 1.) 800 w.

15729. The Duty of a Railroad Company to Its Employés. S. R. Barr (R G-Sept. 8.) 3000 w.

15730. Responsibility for the Long Island Collision. Editorial (R G-Sept. 8.) 1600 w.

15731. Joint Rates and the Long-and-Short-Haul Law. Editorial (R G-Sept. 8.) 1500 w.

15732. The Chester Bridge Disaster. Ill. (E R-Sept. 9.) 2900 w.

Serials.

7456. The Locomotive Boiler. Ill. Gustav Richard (A J R A-Began Oct., 1892—8 parts to date—30 cts. each).

9254. Railway Management. Horace Cope (R R-Began Dec. 31—7 parts to date—15 cts. each).

12001. Rails on the Creep. Ill. E. Ewbank (I E-Began March 11—18 parts to date—45 cts. each).

14125. The Local Transit Problem in London (R W-Began June—3 parts to date—30 cts. each).

14226. Railway Rates and State Control (Tr-Began June 30—9 parts to date—30 cts. each).

14519. The Second Decade of the Massachusetts Railroad Commission (R G-Began July 21—Ended Aug. 18—3 parts—15 cts. each).

15048. Glasgow District Subway. Ill. (I & I-Began Aug. 4—Ended Aug. 11—2 parts—30 cts. each).

15073. The Maintenance of Rates and the Utility of Fast Freight Lines. Junius (R A-Began Aug. 11—Ended Aug. 18—2 parts—15 cts. each).

15303. Steam-Heating Plant for Northern Pacific Railroad Shops. Ill. (E R-Began Aug. 19—2 parts to date—15 cts. each).

15326. Electric Cables. A. E. Kennelly (E R N Y-Began Aug. 26—Ended Sept. 9—2 parts—15 cts. each).

15454. Station Accounts. Their Organization, Management and Examination. H. M. Kochersperger (R R-Began Aug. 26—1 part to date—15 cts).

15526. The Resistance of Cars on Curves. Ill. (R G-Began Sept. 1—2 parts to date—15 cts. each).

SANITARY ENGINEERING.

15031. Tests for Purity of Drinking Water. Francis Wyatt (E M J-Aug. 12.) 2200 w.

15092. The Plenum System of Ventilation as Applied to the New Surgical Buildings of the Montreal General Hospital. Ill. (A Ar-Aug. 12.) 2200 w.

*15104. New Sanitary Laws for London (Pl D–Aug. 1.) 1300 w.

15133. Progress in Sanitary Science in Massachusetts. George W. Fuller (Sc–Aug. 11.) 1500 w.

*15256. The Bacteriological Purification of Sewage. Editorial (Eng L–Aug. 11.) 1800 w.

*15330. Disposal of the Waste of Cities. S. S. Herrick (A H–Sept.) 2000 w.

15403. Cresheim Arch and Intercepting Sewer System, Philadelphia. Ill. (E R–Aug. 26.) 1200 w.

*15414. The Chemistry of Disinfection. G. H. Wilkinson (S R–Aug. 19.) 1500 w.

†15437. Contributions to the Bacteriological Study of the Drinking Waters of the City of Mexico. José Romirez and Manuel Toussaint (San–Sept.) 4800 w.

15522. Shall Our Streams and Lakes be Reserved for Water Supplies or Abandoned to Sewage Pollution? (E N–Aug. 31.) 1200 w.

15541. New York State Plumbing Laws (Met W–Sept. 2.) 2500 w.

†15561. The Utilization of Garbage. Dr. Bruno Terne (J F I–Sept.) 3000 w.

15588. Purification of Sewage and of Water by Filtration. Hiram F. Mills (E R–Sept. 2.) 5200 w.

15608. Education of the Craft.—An Essay delivered at the Milwaukee Convention by the Milwaukee Delegation (S P–Sept.) 3300 w.

*15618. Electricity and the Sewage Problem (E R L–Aug. 25.) 1000 w.

*15653. Scott-Moncrieff's System of Purifying Sewage. Editorial (Inv–Aug. 26.) 1500 w.

*15658. Tenure of Land a Sanitary Question. Hugh Alexander (S R–Aug. 26.) 6000 w.

†15724. How to Stop River Pollution. Frank Spence (C R–Sept.) 2600 w.

Serials.

10425. A Healthy Home. Francis Vacher (S R–Began Feb. 1—14 parts to date—30 cts. each).

11376. Plumbing in the New Netherland Hotel. Ill. (E R–Began March 18—6 parts to date—15 cts. each).

13290. Sewage Disposal. J. Foster Flagg (P–Began June—4 parts to date—30 cts. each).

15062. The Utilization of Town Refuse for River Production. Thomas Tomlinson (E R L–Began Aug. 4—4 parts to date—30 cts. each).

15132. Practical Plumbing (N B–Began Aug. —1 part to date—30 cts).

15221. A Review of Recent Plumbing Practice. Glenn Brown (Met W—Began Aug. 19.—Ended Aug. 26—2 parts—15 cts. each).

15438. Water Filtration and Cholera. R. Koch (San–Began Sept.—1 part to date—45 cts).

STEAM ENGINEERING.

15020. Recent Practice in Pumping Engines. F. W. Dean (E N–Aug. 10.) 6600 w.

15042. The Keene Boiler Explosion.—Data about the Explosion, and Suggestions as to the Cause. J. Humphrey (B J C–Aug. 12.) 1500 w.

15043. Boiler Horse Power.—How a Boiler Maker Figures It (B J C–Aug. 12.) 600 w.

*15122. Progress of Steam Digging, or Land Cultivation (Inv–Aug. 5.) 1200 w.

15164. A Steam Carriage of Sixty Years Ago. Ill. (Sc A S–Aug. 19.) 500 w.

15186. Compression as a Factor in Steam Engine Economy. Frank H. Ball (S M–Aug. 15.) 2500 w.

15224. Sinking a Syphon Trap. Ill. (B J C –Aug. 19.) 500 w.

15225. Heat in Waste Gases.—Relation of Flue Temperature and Grate Area (B J C–Aug. 19.) 900 w.

15226. Economy in Burning Coal.—Some Suggestions as to How It May Be Improved (B J C–Aug. 19.) 1500 w.

*15299. Engine Vibration. Ill. (E–Aug. 11.) 1200 w.

15343. Limitation of Engine Speed (B J C–Aug. 26.) 1800 w.

15344. Progress in Steam Engineering (B J C–Aug. 26.) 600 w.

15357. Stationary Engines at the Columbian Exposition. Ill. (E N–Aug. 24.) 4500 w.

15358. Test of Allis Pumping Engines at Chicago Water Works (E N–Aug. 24.) 600 w.

15385. Compression as a Factor in Steam Engine Economy. Ill. Frank H. Ball (A M–Aug. 24.) 2700 w.

15479. A Comparison of the Thompson, Tabor and Crosby Indicators at about Three Hundred Revolutions. Edward J. Willis (A M –Aug. 31.) 350 w.

15481. An Engine Standard and Cylinder Pattern. Ill. J. H. (A M–Aug. 31.) 1400 w.

15490. The Steam Turbine. James Asher (Sc A S–Sept. 2.) 1200 w.

15554. Compound Engine Tests.—A Steam Jacket that Caused a Loss (B J C–Sept. 2.) 1100 w.

15556. Behavior of Steam (B J C–Sept. 2.) 800 w.

15557. Continuous Economy about a Steam Plant (B J C–Sept. 2.) 800 w.

*15672. Are Water Glasses Necessary? Editorial (N C B–Sept.) 850 w.

15683. Repulsion of Water in Steam Boilers. Frank P. Davis (M N–Sept. 1.) 1300 w.

15699. The Tubular Boiler. Ill. Leicester Allen (T–Sept. 1.) 1500 w.

*15704. Petroleum in Steam Boilers. W. A. Doble (I S F–Sept.) 900 w.

15706. Steam. G. W. Matthews (S E–Aug.) 1300 w.

15707. The Practical Efficiency of Boilers. George West (S E–Aug.) 1500 w.

Serials.

11138. Notes on the Steam Injector. Ill. Strickland L. Kneass (E M–Began March—7 parts to date—30 cts. each).

14040. The Steam Engine (T–Began July 1—5 parts to date—15 cts. each).

14908. The Testing of Boiler Plates (M G–Began Aug. 5—Ended Aug. 12—2 parts—15 cts. each).

15247. Boiler Testing. Messrs. Geipel and Kilgour (El–Began Aug. 11—1 part to date—30 cts).

15600. Steam Consumption per Indicated Horse Power per Hour from the Indicator Diagram. Ill. R. C. Carpenter (P S–Began Sept.—1 part to date—15 cts).

15694. The Graphical Determination of Weights of Fly-wheels of Steam Engines. Ill. Emil Theiss (A M–Began Sept. 7—1 part to date—15 cts).

TELEPHONY AND TELEGRAPHY.

15038. Musical Telegraphy. G. P. Hachenberg (W E–Aug. 12.) 1600 w.

*15064. The Azores Cable (E R L–Aug. 4.) 600 w.

*15282. The Development of Submarine Telegraphy (P Eng–Aug. 11.) 2000 w.

15325. The Marshall Telephone. Ill. Julian A. Moses (E R N Y–Aug. 26.) 1200 w.

*15372. The Telephone Patents. A. G. Holcombe (S R E N–Aug.) 850 w.

15460. Ocean Telephony. Ill. Sylvanus P. Thompson (E R N Y–Sept. 2.) 4500 w.

15472. Laying of the Submarine Telegraph Cable between the Isle of Shoals, N. H., and the United States. Ill. (E E N Y–Aug. 30.) 800 w.

15650. New Felten and Guilleaume Telephone Cables. Ill. (E E N Y–Sept. 6.) 850 w.

MISCELLANEOUS.

*14991. Recent Progress in Siam. Ill. J. B. Breuer (E Mag–Oct.) 3000 w.

*14994. The Camel as a Freight-Carrier. Ill. Edmund Mitchell (E Mag–Oct.) 3000 w.

14997. Cottonseed Oil as a Source of Rubber. C. B. Warrand (M R–Aug. 11.) 1400 w.

15018. Proposed Code of Engineering Ethics (E N–Aug. 10.) 1800 w.

15029. Mr. Balfour on Silver (E M J–Aug. 12.) 1500 w.

*15051. A Year's Work in Explosives (I & I–Aug. 4.) 1500 w.

15065. The Management of Man (M G–Aug. 12.) 1800 w.

*15090. The Luminiferous Ether. G. C. Stokes (El–Aug. 4.) 3500 w.

*15093. Heat Transmission Through Metal Plates. Ill. John G. Hudson (Eng L–Aug. 4.) 4600 w.

*15096. The Principles of Combustion. Editorial (Eng L–Aug. 4.) 1600 w.

15146. Mechanical Flight. Hiram S. Maxim (S V–Aug. 15.) 1300 w.

15161. Some Extinct Lakes. Ralph S. Tarr (Sc A–Aug. 19.) 2000 w.

15193. The Metric System. Decimal, with Editorial (E N–Aug. 17.) 1200 w.

15205. Stock-Raising and Dairying in the South. H. B. Wetzell (M R–Aug. 18.) 4000 w.

†15218. Lessons from the Culture of Quinine (I R W–Aug. 15.) 950 w.

†15219. Rubber-Planting on the Isthmus of Tehuantepec. F. O. Harriman (I R W–Aug. 15.) 1000 w.

†15220. Cottonseed-Oil as a Rubber Substitute. Robert Grimshaw (I R W–Aug. 15.) 400 w.

15238. Engineering Methods in Book-Keeping. Frederic A. C. Perrine (E M J–Aug. 19.) 1700 w.

*15245. Logic and Engineering. Editorial (El–Aug. 11.) 1400 w.

*15252. Mr. Gladstone on Industry and Art (A L–Aug. 11.) 3000 w.

*15267. The Combustion of Fuel and Conversion into Mechanical Work. Editorial (Inv–Aug. 12.) 1000 w.

15278. Progress in Flying Machines. O. Chanute (Eng–Aug. 19.) 1400 w.

*15289. A New Determination of the Mechanical Equivalent of Heat. Ill. Rollo Appleyard (E R L–Aug. 11.) 1700 w.

*15297. Arbitration. Editorial (E–Aug. 11.) 1200 w.

†15321. Why Silver Ceases to Be Money. F. W. Taussig (P S M–Sept.) 4200 w.

†15322. Anthropology at the World's Fair. Ill. Frederick Starr (P S M–Sept.) 4200 w.

†15370. A Century's Struggle for Silver. John Bach McMaster (F–Sept.) 4500 w.

15383. International Conference on Aerial Navigation. O. Chanute (Sc A S–Aug. 26.) 2700 w.

15386. Rules and Their Exceptions.—It Pays to Think. Peter H. Bullock (A M–Aug. 24.) 1000 w.

†15394. A Money Famine in a Nation Rich in Money's Worth. George C. Douglass (A–Sept.) 6500 w.

†15395. Seven Facts about Silver. W. H. Standish (A–Sept.) 4300 w.

*15429. The Artificial Caverns at Lavant. Charles Dawson (A L–Aug. 18.) 2200 w.

*15451. English and Continental Engineering. Editorial (Eng L–Aug. 18.) 1500 w.

15491. The Cotton-Seed Oil Industry (Sc A S–Sept. 2.) 1000 w.

†15508. Sights at the Fair. Ill. Gustav Kobbé (C M–Sept.) 2400 w.

†15512. The Silver Problem.—I. A Word to Wage Earners.—Andrew Carnegie. II. The Present Crisis.—John Lubbock (N A R–Sept.) 10500 w.

15553. Graphite: Its Uses and Durability as a Paint. John A. Walker (A & B–Sept. 2.) 2000 w.

†15560. A New Tele-Photo Lens. Ill. Julius F. Sachse. (J F I–Sept.) 1200 w.

†15572. The Organization of the World's Columbian Exposition. Daniel H. Burnham (I A-Aug.) 5000 w.

*15576. The Silver Situation in Colorado. Edward W. Bemis (R of R-Sept.) 3200 w.

*15577. A Letter on the Silver Question from Prof. von Holst (R of R-Sept.) 2000 w.

*15583. A World's Fair. Ill. Articles by Walter Besant, Price Collier, George F. Kunz, Ellen M. Henrotin, Julian Hawthorne, Murat Halstead, J. B. Walker, F. J. V. Skiff, H. C. Chatfield-Taylor, F. T. Bickford, Franz Boaz, and Benjamin Harrison (Cos-Sept.) 39000 w.

*15601. Engineers of To-day—and Yesterday.—The Brothers Siemens. Ill. J. (E Rev-Aug. 21.) 2700 w.

*15648. The Rothamsted Experiments. Ill. (I & I-Aug. 25.) 2500 w.

15649. Electricity at the Hebrew Technical Institute, New York City. Ill. (E E N Y-Sept. 6.) 600 w.

*15652. Combination Heating. George D. Hoffman (B A-Aug. 25.) 1300 w.

Serials.

9401. World's Columbian Exposition (E N-Began Jan. 5—20 parts to date—15 cts. each).

13620. One Way to See the Exposition. Ill. Fred De Land (W F E E-Began June—3 parts to date—30 cts. each).

13998. The Future of the Hot-Air Furnace. A. W. Glessner (Met W-Began July 1—11 parts to date—15 cts. each).

14545. American Universities at the Columbian Exposition (E-Began July 14—5 parts to date—30 cts. each).

14742. Woven Wire and Segregation. Ill. Bryan Coucoran (Inv-Began July 22—Ended Aug. 25—5 parts—30 cts. each).

14792. The Steering of Balloons. Ill. Rudolphe Soreau (A E R J-Began Aug.—2 parts to date—30 cts. each).

14878. Linen and Invention (Inv-Began July 29—2 parts to date—30 cts. each).

15237. The Preservation of the White Mt. Forests. George B. James (M G-Began Aug. 19—3 parts to date—15 cts. each).

15302. Timber Physics (E R-Began Aug. 19—2 parts to date—15 cts. each).

15433. British Colonies at Chicago (E-Began Aug. 18—1 part to date—30 cts).

15559. Carborundum: Its History, Manufacture and Uses. E. G. Acheson (J F I-Began Sept.—1 part to date—45 cts).

15571. Painting and Sculpture at the World's Fair. H. C. Payne (I A-Began Aug.—1 part to date—45 cts).

THE TECHNICAL INDEX

A CATALOGUE OF LEADING ARTICLES PUBLISHED CURRENTLY IN THE TECHNICAL JOURNALS OF THE UNITED STATES AND GREAT BRITAIN.

THIS publication has been aptly described as "the greatest step that has been taken in recent years towards systematizing work" for the engineer, the architect, the electrician, the railway manager, and the business man. The list of publications regularly indexed will show that it covers a world-wide range of the best technical literature, and all the articles are so conveniently classified under general headings that within a few minutes an active man can learn of everything that has been published during the month in relation to his special lines of investigation. In short, it is to the practical man just what Poole's celebrated index to periodicals has long been to the literary worker, but with this essential difference,—namely, that in addition to indicating *just where* leading articles have been published, *we undertake to supply copies of the articles themselves.* The unparalleled convenience and economy of this double service can readily be appreciated.

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[In the body of the index only the initials of the journals quoted are given, and these can be readily identified by the following list of periodicals. Other abbreviations are: Ill=Illustrated. w=words.]

THE AMERICAN PRESS.

A .....Arena. *m.* $5 per year. Boston.
AA.....American Architect. *w.* $6. Boston.
Aer.....Aeronautics. *m.* $1. N. Y.
An A A..Annals of Am. Academy of Political and Social Science. *b-m.* $6. Philadelphia.
A An.... American Analyst. *f.* $1. New York.
A Ar.... American Artisan. *w.* $2. Chicago.
A & B....Architecture and Building. *w.* $6. N. Y.
A C J....Am. Chem. Journal. *b-m.* $4. Baltimore.
A E .....Architectural Era. *m.* $3. New York.
A E R J..Am. Eng. and Railroad Journal. *m.* $3. N.Y.
A G.....Am. Geologist. *m.* $3.50. Minneapolis.
A G L J..Am. Gas Light Journal. *w.* $3. New York.
A H.....Annals of Hygiene. *m.* $2. Phila.
A J Phar.Am. Journal of Pharmacy. *m.* $3. Phila.
A J R A..Jour. R'y. Appliances. *m.* $2. New York.
A M.....American Machinist. *w.* $3. New York.
A M & I W.Am. Man. and Iron World. $4. Pittsburg.
Am A....American Agriculturist. *m.* $1.50. N.Y.
Am G....American Gardening. *m.* $1. New York.
Am S....American Shipbuilder. *w.* $2. New York.
A & N J..Army and Navy Journal. *w.* $6. New York.
A & N R..Army and Navy Register. *w.* $3. Wash'ton.
A Rev....Architectural Review. *s-q.* $5. Boston.
A S .....Age of Steel. *w.* $3. St. Louis.
B B.....Brick Builder. *m.* $2.50. Boston.
B C.....Boston Commonwealth. *w.* $2.50. Boston.
B & D...Builder and Dec. *m.* $2. Minneapolis.
B I S....Bul. Am. Iron and St. Asso. *w.* $4. Phila.
B J C....Boston Jour. of Commerce. *w.* $3. Boston.
B & W...Builder and Woodworker. *m.* $1. N. Y.
C.....Compass. *m.* $1. New York.
C A.....Calif. Architect. *m.* $3. San Francisco.
Can A.. Canadian Architect. *m.* $2. Toronto.
C & B... Carpentry and Building. *m.* $1. New York.
C E .....Colliery Engineer. *m.* $2. Scranton, Pa.
C E N... Canadian Elec. News. *m.* $1. Toronto.
C Eng....Canadian Engineer. *m.* $1. Montreal.
Ch.....Chautauquan. *m.* $2. Meadville, Pa.
C M.....Century Magazine. *m.* $4. New York.
Cos.....Cosmopolitan. *m.* $1.50. New York.
D E.....Domestic Engineering. *m.* $1. Chicago.
E A.....Electrical Age. *w.* $3. New York.
E E N Y..Electrical Engineer. *w.* $3. New York.
E I.....Electrical Industries. *m.* $3. Chicago.
E M.....Engineering Mechanics. *m.* $2. Phila.
E Mag ...Engineering Magazine. *m.* $3. New York.
E M J....Eng. and Mining Journal. *w.* $5. N.Y.
E N.....Engineering News. *w.* $5. New York.
Eng .....Engineer. *s-m.* $2. New York.
E N Y....Electricity. *w.* $2.50. New York.
E R.....Engineering Record. *w.* $5. New York.
E R N Y..Electrical Review. *w.* $3. New York.
E & R ...Elec. and Railroading. *m.* $1. Boston.
E S W P...Proc. Eng. So. of W.Pa. *m.* $7. Pittsburg.
E W.....Electrical World. *w.* $3. New York.
F .....Forum. *m.* $5. New York.
F D.....The Foundry. *m.* $1. Detroit.
F W.....Fire and Water. *w.* $3. New York.
G & F....Garden and Forest. *w.* $4. New York.
G G M...Goldthwaite's Geograp. Mag. *m.* $2. N. Y.
G R.....Good Roads. *m.* $2. New York.

I A.....Inland Architect. *m.* $5. Chicago.
I Age....Inventive Age. *s-m.* $1. Washington.
Ir Age..Iron Age. *w.* $4.50. New York.
I I G.....Iron Ind. Gazette. *m.* $1.50. Buffalo.
I R W...India Rubber World. *m.* $3. New York.
I S F.....Industry. *m.* $2. San Francisco.
I T R....Iron Trade Review. *w.* $3. Cleveland.
J A... ..Journal of Architecture. *m.* $2. Phila.
J A C S..Jour. Am. Chem. So. *m.* $5. Easton.
J A E S..Jour. Assoc. Eng. Soc. *m.* $3. Chicago.
J F I.....Jour. Franklin Institute. *m* $5. Phila.
J M S I..Jour. Milit. Service In. *b-m.* $4. NewYork.
J N E W.Jour. N. E. Waterw. Ass. *q.* $2. New London.
J P E.....Jour. Polit. Economy. *q.* $3. Chicago.
J U S A..Jour. U. S. Artillery. *q.* $2.50. Ft. Monroe.
L E.....Locomotive Engineering. *m.* $2. N. Y.
L Mag...Lippincott's Magazine. *m.* $3. Phila.
M & B...Manufacturer and Builder. *m.* $1.50. N. Y.
M & El...Mech. and Electrician. *w.* $2. St. Louis.
Met W...Metal Worker. *w.* $2. N. Y.
M G.....Manufacturer's Gazette. *w.* $2.50. Boston.
Min.....Minerals. *m.* $1. N. Y.
Min. R...The Mining Review. *w.* $2. Denver.
M I T....Mining Industry. *w.* $3. Denver.
M N.....Mechanical News. *s-m.* $1.50. New York.
M R.....Manufacturer's Record. *w.* $4. Baltimore.
M R C...Marine Review. *w.* $2. Cleveland, O.
M Rec....The Marine Record. *w.* $2. Cleveland.
M S P....Min. and Sci. Press. *w.* $3. San Francisco.
M S R....Mining and Sci. Review. *w.* $2. Denver.
N A R...North American Review. *m.* $5. N. Y.
N B .....National Builder. *m.* $3. Chicago.
N C B...National Car Builder. *m.* $2. New York.
N P R...Nat. Popular Review. *m.* $2.50. Chicago.
N W.....Nowest. Architect. *m.* $3. Minneapolis.
O P D R..Oil, Paint and Drug Reporter. *w.* $6. N.Y.
P.....Paving. *m.* $2. Indianapolis.
P A.....Progressive Age. *s-m.* $3. New York.
P D.. ...Painting and Decorating. *m.* $1. Phila.
P E. .....Practical Electricity. *f.* $2. Boston.
P S.....Power-Steam. *m.* $1. N. Y.
P S M....Popular Science Monthly. *m.* $5. N. Y.
R A.....Railway Age. *w.* $4. Chicago.
R C J....Railroad Car Journal. *m.* $1. New York.
R G .....Railroad Gazette. *w.* $4.20. N. Y.
R M.....Roller Mill. *m.* $2. Buffalo, N. Y.
R M M..Railway Master Mechanic. *m.* $1. Chicago.
R of R...Review of Reviews. *m.* $2.50. New York.
R R.....Railway Review. *w.* $4. Chicago.
R & T...Roofer and Tinner. *m.* $1. N. Y.
R'y N....Railway News. *m.* $2. New York.
S... .....Stone. *m.* $2. Indianapolis, Ind.
S A.....Southern Architect. *m.* $2. Atlanta.
San.....Sanitarian. *m.* $4. Brooklyn.
Sc.....Science. *w.* $3.50. New York.
Sc A ....Scientific American. *w.* $3. New York.
Sc A S ...Scientific Am. Supplement. *w.* $5. N. Y.
Sc M....Scribner's Magazine. *m.* $3. New York.
S E .....Stationary Engineer. *w.* $2. Chicago.
Sc Q.....Scientific Quarterly. *q.* $2. Golden, Cal.
Sea.....Seaboard. *w.* $2. New York.
S Ec.....Social Economist. *m.* $2. New York.
S J E....Sibley Jour. of Eng. *m.* $2. Ithaca, N. Y.
S M.....ScientificMachinist. *s-m.* $1.50. Cleveland, O.
So L.....Sou. Lumberman. *s-m.* $2. Nashville.
S M Q....School of Mines Quarterly. $2. N. Y.
S R E N..St. R'y. Elec. News. *m.* $2. Minneapolis.
S P.....Sanitary Plumber. *s-m.* $1. New York.
S R G....Street Railway Gazette. *w.* $3. Chicago.
S R J....Street Railway Journal. *m.* $4. New York.
S R N. ..Street Railway News. *w.* $3. New York.
S R R.. .Street Railway Review. *m.* $2. Chicago.
S S.....Southern States. *m.* $1.50. Baltimore.
S V.....Safety Valve. *m.* $1. New York.
T... ....Tradesman. *s-m.* $2. Chattanooga, Tenn.
T A I E E.Trans. Am. Ins. Elec. Eng. *m.* $5. N. Y.
T C E....Trans. Am. Soc. Civil Eng. *m.* $10. N. Y.
T Q.....Technology Quarterly. $3. Boston.
W E.....Western Electrician. *w.* $3. Chicago.
W F E E.World's Fair Elec. Eng. *m.* $3. Chicago.
W G R..Water and Gas Review. *m.* $1. New York.

THE FOREIGN PRESS.

A L.....The Architect. *w.* 26*s.* London.
A M S.. Aust. Mining Standard. *w.* 30*s.* Sydney.
A P R...Aus. Pastoralists' Rev. *m.* 30*s.* Sydney.
B A... .The British Architect. *w.* 23*s.* 8*d.* London.
C G.. ..Colliery Guardian. *w.* 27*s.* 6*d.* London.
C R.....Contemporary Review. *m.* $4.50. London.
C T J....Chem. Trade Jour. *w.* 12*s.* 6*d.* Manchester.
D.....Discovery *w.* 8*s.* 8*d.* London.
E.....Engineering. *w.* 36*s.* London.
E E L....Electrical Engineer. *w.* 17*s.* 4*d.* London.
E G.....Engineers' Gazette. *m.* 4*s.* London.
E L.....Electricity. *w.* 6*s.* 6*d.* London.
El.. .....Electrician. *w.* 24*s.* London.
EngL... Engineer. *w.* 36*s.* London.
E P.....Electrical Plant. *m.* 6*s.* London.
E Rev....Engineering Review. *m.* 7*s.* London.
E R L.....Electrical Review. *w.* 21*s.* 8*d.* London.
F R.....Fortnightly Review. *m.* $4.50. London.
G E M...Gas Engrs' Mag. *m.* 6*s.* 6*d.* Birmingham.
G W.....Gas World. *w.* 13*s.* London.
I.....Iron. *w.* 30*s.* London.
I & I.....Industries and Iron. *w.* £1. London.
I & S.....Iron and Steel Trades' Jour. *w.* 25*s.* London.
I C B.....Carpenter and Builder. *w.* 8*s.* 8*d.* London
I C T.....Iron and Coal Review. *w.* 30*s.* 4*d.* London.
I E.....Indian Engineering. *w.* 18 Rs. Calcutta.
Inv.....Invention. *w.* 28*s.* London.
J G L....Journal of Gas Lighting. *w.* London.
J S A....Journal of the So. of Arts. *w.* London.
K.....Knowledge. *m.* 6*s.* London.
M.....Machinery. *m.* 9*s.* London.
M E.....Marine Engineer. *m.* 7*s.* 6*d.* London.
M E & E J.Man. Eng. and Export Jour. *m.* London.
Min W..The Mining World. *w.* 21*s.* London.
M W.....Mechanical World. *w.* 8*s.* 8*d.* London.
N..... Nature. *w.* $7. London.
N C.....Nineteenth Century. *m.* $4.50 London.
P Eng...Practical Engineer. *w.* 10*s.* London.
Pl D.....Plumber and Decor. *m.* 6*s.* 6*d.* London.
R N.....Railway News. London.
R P L....The Railway Press. *m.* 7*s.* London.
R R L...The Railway Review. *w.* London.
R W.....Railway World. *m.* $3. London.
S L.....Steamship. *m.* Leith, Scotland.
S R.....Sanitary Record. *m.* 10*s.* London.
Tr.....Transport. *w.* £1. 5*s.* London.
W R.....Westminster Review. *m.* $4.50. London.

ARCHITECTURE.

*15753. The New Home for Incurables at Newcastle (I C B-Sept. 1.) 1500 w.

*15832. Simple Trussed Beams for Roofs and Bridges (N B-Sept.) 900 w.

*15900. Suggestions for Designs from Foliage. The Thistle. Ill. H. Leslie Ramsey (Pl D-Sept.) 1200 w.

15941. The New City Hall (A & B-Sept. 16.) 800 w.

15944. The Architect, the Engineer, and the Contractor, with Discussion. G. Allen Mansfield (A A-Sept. 16.) 5500 w.

15947. Some Constructions in Linear Perspective. Ill. F. R. H. (A A-Sept. 16.) 500 w.

*15975. Wembley Park Tower. Ill. (Eng L-Sept. 8.) 900 w.

16054. Architectural Science. George C. Mason (A & B-Sept. 23.) 4200 w.

16070. Foundations of High Buildings. W. R. Hutton (E R-Sept. 23.) 3400 w.

*16072. The Doric Order.—Reprint from Granite Cutter's Journal (Can A-Sept.) 600 w.

*16073. Technical Requirements of Architects.—Reprint from Building News (Can A-Sept.) 1500 w.

*16082. The Art of the White City. Ill. Will H. Low (Sc M-Oct.) 4000 w.

16133. On Architectural Practice of the United States Government. Jeremiah O'Rourke (A A-Sept. 23.) 2500 w.

*16135. Charlton on-Thames and Its History. W. F. Potter (A L-Sept. 15.) 3000 w.

*16142. Bosses and Crockets. Ill. (I C B-Sept. 15.) 600 w.

16190. Ignorance Concerning Woods. Mr. Saley (A & B-Sept. 30.) 3000 w.

16260. Laying Out a Balloon Frame (T-Oct. 1.) 2000 w.

16263. Library Buildings. J. G. Smithmeyer (A A-Sept. 30.) 3000 w.

16264. Architectural Drawings at Chicago (A A-Sept. 30.) 3300 w.

*16273. British Marsh Dwellings (A L-Sept. 22.) 900 w.

*16274. The Remains at Aksum, Abyssinia (A L-Sept. 22.) 2800 w.

*16275. Haddon Hall (A L-Sept. 22.) 1200 w.

16303. "Weaving Shed" Design for Shop Construction. Ill. (C & B-Oct.) 1700 w.

16336. Moving of a Large Masonry Building in Chicago. Ill. (Sc A S-Oct. 7.) 800 w.

*16403. The Chronology of Architecture.—Review of book by J. Tavenor Parry (A L-Sept. 29.) 3200 w.

*16404. The Seven Churches of Clonmacnois (A L-Sept. 29.) 2000 w.

16462. Our State Capitols (A & B-Oct. 7.) 2000 w.

Serials.

7121. Office-Help for Architects. Ill. George Hill (A A-Began Oct. 8, 1892—19 parts to date—15 cts. each).

12568. Building Construction and Superintendence. Ill. F. E. Kidder (A & B-Began May 6—11 parts to date—15 cts. each).

13358. Modern Asylums for the Insane. Ill. George H. Bibby (A A-Began June 3—5 parts to date—15 cts. each).

13919. The Use and Abuse of Precedent. Ill. H. Langford Warren (A Rev-Began Feb. —2 parts to date—45 cts. each).

14753. Architecture at the World's Columbian Exposition (I A-Began July—3 parts to date—45 cts. each).

15271. The Open Fireplace, Past and Present (I C B-Began Aug. 11—Ended Sept. 1—4 parts—30 cts. each).

15747. Excursions of Cambrian Archæological Association (B A-Began Sept. 1—Ended Sept. 8—2 parts—30 cts. each).

15789. Italian Cities—Venice (A A-Began Sept. 9—2 parts to date—15 cts. each).

15930. Evolution of the Construction Faculty. John M. Burnett (I C B-Began Sept. 8 —Ended Sept. 15—2 parts—30 cts. each).

15942. Apses. Ill. A. de Baudot (A A-Began Sept. 16—2 parts to date—15 cts. each).

16047. The Metal Worker Sky-Light Competition. Ill. (Met W-Began Sept. 23—1 part to date—15 cts).

CIVIL ENGINEERING.

*15797. To Bridge the Hudson at New York. Gustav Lindenthal (E Mag-Nov.) 3000 w.

*15811. The Prevention of the "Falling" of Portland Cement. Editorial (Eng L-Sept. 1.) 1300 w.

*15828. Manchester Ship Canal Prospects (E-Sept. 1.) 1300 w.

†15834. The Relation of the Unit Stress and Cross-Section in Curved Members. Ill. J. L. Greenleaf (S M Q-July.) 1300 w.

†15835. The Adjustment of Triangulation. E. M. Douglas (S M Q-July.) 5500 w.

15861. The Opening of the Corinth Canal. Ill. (Sc A S-Sept. 16.) 1300 w.

15881. Two Curiosities in Highway Bridge Designing. Ill. (E N-Sept. 14.) 2500 w.

15885. The Third Ave. Bridge over the Harlem River. Ill. (R G-Sept. 15.) 1200 w.

15935. The Foundation of the River Piers of the Tower Bridge. Ill. Edward Wilson Cruttwell (R R-Sept. 16.) 4000 w.

15943. The New Blackwall Tunnel under the River Thames (A A-Sept. 16.) 2600 w.

*15960. The La Guaira Harbor Works, Venezuela. Ill. A. E. Carey (E-Sept. 8.) 2700 w.

*15973. Underground Operations at Glasgow (Eng-Sept. 8.) 4000 w.

*15979. Proposed Bridges over the Danube

at Budapest.—Competitive Designs. Ill. (Eng L–Sept. 8.) 1200 w.

*15985. More New Canals in France and Germany (Tr–Sept. 8.) 1000 w.

16037. The Sacramento Avenue Subway, Chicago. Ill. (E N–Sept. 21.) 6500 w.

16038. Notes on Pile Foundations in Chicago (E N–Sept. 21.) 1800 w.

*16106. The Distribution of Load on Trough Floors for Bridges. Ill. (E–Sept. 15.) 2800 w.

†16146. Discussion of H. D. Whitcomb's paper—"The Improvement of the James River." Charles B. Brush, Edgar B. Gosling, W. R. Hutton, J. J. R. Croes, John Bogart, F. S. Washburn, W. P. Craighill, and H. D. Whitcomb (T C E–June.) 4300 w.

16167. The Use of Mattresses in Bridge Foundations. Ill. (R G–Sept. 29.) 900 w.

†16198. Street-Paving in America. Ill. William Fortune (C M–Oct.) 7200 w.

16251. The Office of City Civil Engineer in Small Cities. H. F. Dunham (E R–Sept. 30.) 1000 w.

*16329. The Use of Silica Gravel in Concrete. E. J. De Smedt (P–Oct.) 3300 w.

*16331. Special Specifications for Asphalt, Stone Blocks and Bricks (P–Oct.) 1500 w.

16360. The Canadian Pacific Railway Portland Cement Works in Vancouver, B. C. (E N–Oct. 5.) 1000 w.

16361. The Brown Cantilever Hoists on the Chicago Drainage Canal. Ill. (E N–Oct. 5.) 900 w.

16382. A New Bridge at Chicago.—The Lift Bridge. Ill. (M N–Oct. 1.) 300 w.

Serials.

8671. Macadam and Telford Roads. Ill. Isaac B. Potter (G R–Began Nov.—4 parts to date—30 cts. each).

13194. Highway Bridges. Ill. John N. Ostrom (G K–Began May—5 parts to date—30 cts. each).

14704. Brick Pavements (E R–Began July 29—3 parts to date—15 cts. each).

15638. Bonar Bridge. Ill. (E–Began Aug. 25—Ended Sept. 8—2 parts—30 cts. each).

15927. The Contra Costa Road Plan. Ill. A. L. Bancroft and C. M. Plumb (G R–Began Sept.—1 part to date—30 cts).

16282. The Tower Bridge. Ill. (E–Began Sept. 22—2 parts to date—30 cts. each).

ELECTRICAL MISCELLANY.

*15740. The Underground System at the World's Fair (E I–Sept.) 700 w.

†15749. High Frequency Electric Induction. Elihu Thompson (T Q–April) 4000 w.

†15750. Electrolytic Reduction of Nitrobenzene in Sulphuric and Acid Solution. Arthur A. Noyes and Arthur A. Clement (T Q–April) 700 w.

*15777. The Use of Cupric Nitrate in the Voltameter and the Electro-Chemical Equivalent of Copper. Frederick E. Beach (El–Sept. 1.) 2200 w.

*15783. Armature Proportions. Ill. F. M. Weymouth (E E L–Sept. 1.) 3000 w.

*15793. High Frequency Currents and "Harmlessness." W. S. Hedley (E R L–Sept. 1.) 1300 w.

15840. Bradley's High Potential Direct Current Dynamo or Motor. Ill. (E E N Y–Sept. 13.) 400 w.

15841. "The Moment of Reversal." D. B. Grandy (E E N Y–Sept. 13.) 350 w.

15842. Storage Batteries in French Central Stations (E E N Y–Sept. 13.) 1000 w.

15843. The Pollak Commutator for Converting Alternate into Continuous Currents. Ill. (E E N Y–Sept. 13.) 2200 w.

15844. The Electrical Equipment of a Modern Residence at Erie, Pa. Ill. (E E N Y–Sept. 13.) 900 w.

15852. Various Uses of the Electrostatic Voltmeter. J. Schulka (E W–Sept. 16.) 800 w.

15853. A New Method for Obtaining High Potential Currents. Ill. P. Oudin (E R N Y–Sept. 16.) 2200 w.

15854. Edward Hospitalier, in an Interview, Criticises the World's Fair and the Electrical Congress. J. A. M. (E R N Y–Sept. 16.) 800 w.

15866. The Design of Electric Generators. Ill. Horace F. Parshall (S R G–Sept. 9.) 2000 w.

*15922. Electrolysis at Definite Electrical Pressures. Bertram Blount (El–Sept. 8.) 1100 w.

*15933. A Mechanical Effect of Very Rapid Electric Oscillations. Ill. L. Bleekrode (E R L–Sept. 8.) 900 w.

15998. Brick Burning by Electricity (T–Sept. 15.) 1750 w.

†16005. A New Method for the Control of Electric Energy. Ill. D. McFarlan Moore (T A I E E–Aug.–Sept.) 3800 w.

*16016. The Artificial Reproduction of the Diamond. Leo Dex (Ch–Oct.) 3300 w.

16019. How the Electrical Industries Withstood the Financial Stress (E W–Sept. 23.) 5000 w.

16020. The General Electric Company at the World's Fair. Ill. John M'Ghee (E W–Sept. 23.) 1600 w.

16023. The Desroziers Continuous Current Dynamo. Ill. (E E N Y–Sept. 20.) 2500 w.

16035. Long Distance Transmission.—Multiphase Motors. George Forbes (E N Y–Sept. 20.) 5500 w.

†16046. Sketch of Werner von Siemens. Ill. (P S M–Oct.) 3500 w.

*16092. Address of R. T. Glazebrook to the Mathematical and Physical Section of the British Association (E E L–Sept. 15.) 7000 w.

16156. Discussion on Multiphase Motors. Mr. Hanson, Dr. Bell, Mr. Stillwell, Mr. Freke, Prof. Forbes, Mr. Steinmetz (E N Y–Sept. 27.) 7500 w.

16157. Notes on an Inductor Alternator. Ill. M. M. Maghee (E E N Y–Sept. 27.) 1000 w.

16159. The Electro-Deposition of Iridium; A Method of Maintaining the Uniform Composition of an Electro-Plating Bath Without the Use of an Anode. William L. Dudley (E R N Y-Sept. 30.) 700 w.

16160. The Mechanical and Electrical Oscillators of Nikola Tesla. Julian A. Moses (E R N Y-Sept. 30.) 2000 w.

*16224. Note on the Utilization of Waste Water-Power by Electricity. Albion J. Snell (E R L-Sept. 22.) 3500 w.

*16225. On the Piezo-Electric Property of Quartz. Ill. Lord Kelvin (E R L-Sept. 22.) 2500 w.

*16230. Relative Cost of Conductors with Different Systems of Electric Power Transmission. Gesbert Kapp (E E L-Sept. 22.) 950 w.

*16231. On a Piezo-Electric Pile. Lord Kelvin (E E L-Sept. 22.) 400 w.

*16245. Horse Power and the Watt (El-Sept. 22.) 800 w.

*16246. Dr. Oettels' Researches on the Electro-Deposition of Copper (El-Sept. 22.) 850 w.

*16248. Self-Exciting Armatures for Electric Current Dynamo Electric Machines and Compensators for Loss of Pressure in Feeders of Electric Supply Systems. Ill. W. B. Sayers (El-Sept. 22.) 1200 w.

*16283. Electric Forging. Editorial (E-Sept. 22.) 1300 w.

16300. Electricity of the Sun. G. P. Hachenberg (E R N Y-Oct. 7.) 2700 w.

16301. The Bradbury-Stone Storage Battery. Henry W. Morton (E R N Y-Oct. 7.) 900 w.

16319. An Improved Form of Instrument for the Measurement of Magnetic Reluctance. Ill. A. E. Kennelly (E W-Oct. 7.) 1200 w.

16332. Electricity and Its Uses in a Modern Newspaper Office.—The New York Herald Building. Ill. (E N Y-Oct. 4.) 1000 w.

16334. Materials for Wire Standards of Electrical Resistance. (Abstract) Stephen Lindeck (E N Y-Oct. 4.) 2000 w.

16376. The Education of the Electrical Engineer, with Discussion. E. B. Merrill (C E N-Oct.) 4600 w.

†16391. The Chloride Electrical Storage Battery. Ill. Herbert Lloyd (J F I-Oct.) 2800 w.

*16436. Recent Advances in Electric Heating. Ill. (E R L-Sept. 29.) 1400 w.

*16438. On Standards of Low Electrical Resistance. Viriamu Jones (E E L-Sept. 29.) 1500 w.

*16439. Experiments for Improving the Construction of Practical Standards for Electrical Measurements (E E L-Sept. 29) 4500 w.

*16454. The Electrical Congress of Chicago. Silvanus P. Thompson (El-Sept. 29.) 4000 w.

*16457. Transmission of Electric Signals Through Space. Ill. Willoughby S. Smith (El-Sept. 29.) 1500 w.

16465. Popular Misconceptions Concerning Electricity (M G-Oct. 7.) 1000 w.

*16468. The Business End of Electricity. (Abstract.) H. C. Thom (E I-Oct.) 1700 w.

Serials.

11501. Theory of the Transformer. Frederick Bedell and Albert C. Crehore (E W-Began March 25—6 parts to date—15 cts. each).

11560. Electricity as a Motive Power. Albion T. Snell (El-Began March 17—10 parts to date—30 cts. each).

13013. Alternate-Current Transformer Design. R. W. Weekes (E E L-Began May 12—Ended Sept. 1—9 parts—30 cts. each).

15269. The Practical Measurement of Alternating Electric Currents. Ill. J. A. Fleming (J S A-Began Aug. 11—4 parts to date—30 cts. each).

15431. Means of Diminishing Sparking in Continuous-Current Dynamos. Ill. W. C. Rechniewski (E E L-Began Aug. 18—Ended Sept. 15—3 parts—30 cts. each).

15476. Judging the Electrical Exhibits at the World's Fair. Hermann S. Hering (E W-Began Sept. 2—4 parts to date—15 cts. each).

15784. Patin Fly-Wheel Alternator. Ill. (E E L-Began Sept. 1—Ended Sept. 8—2 parts—30 cts. each).

15925. Landmarks in the History of Electro-Chemistry. Ill. W. W. Haldane Gee (El-Began Sept. 8—Ended Sept. 22—3 parts—30 cts. each).

16044. Electricity at the World's Fair. Ill. Charles M. Lungren (P S M-Began Oct.—1 part to date—45 cts).

16093. Address of Jeremiah Head to the Mechanical Science Section of the British Association (E E L-Began Sept. 15—Ended Sept. 22—2 parts—30 cts. each).

16096. Commercial Magnetism. J. S. (I & I-Began Sept. 15—3 parts to date—30 cts. each).

15228. Electric Supply Companies (E E L-Began Sept. 22—Ended Sept. 29—2 parts—30 cts. each).

16453. An Examination of Prof. Lodge's Electro-Magnetic Hypothesis. J. H. Poynting (El-Began Sept. 29—1 part to date—30 cts).

16458. Design of Alternating-Current Motors. Ill. Emil Kolben (El-Began Sept. 29—1 part to date—30 cts).

ELECTRIC LIGHTING.

*15737. Objections to Municipal Electric Lighting (E P-Sept. 1.) 1500 w.

*15776. The Placing of Arc Lamps. Llewellyn Preece (El-Sept. 1.) 1100 w.

*15794. Arc and Incandescent Lighting (E R L-Sept. 1.) 1600 w.

15849. On the Maximum Efficiency of Arc Lamps with Constant Watts. H. S. Carhart (E W-Sept. 16.) 700 w.

15850. On the Swinburne-Thompson Unit of Light. Silvanus P. Thompson (E W-Sept. 16.) 1000 w.

15855. An Interesting Electric Light and

Power Installation Between Lugano, Capolago and Maroggia (E R N Y–Sept. 16.) 700 w.]

15867. Municipal Plants—Some Suggestions Offered by an Advocate of City Ownership (E N Y–Sept. 13.) 1100 w.

*15932. Hints on Arc Lamps (E R L–Sept. 8.) 1200 w.

16024. Automatic Apparatus for Preventing the Unauthorized Use of Electric Light Current. Ill. (E R N Y–Sept. 23.) 850 w.

16025. Illumination of the Sailors' and Soldiers' Monument at Indianapolis (E R N Y–Sept. 23.) 600 w.

*16066. Devices for Permanent Control of the Insulation and for Automatic Indication of Faults in Conducting Networks. Dr. M. Kallman (E L–Sept. 15.) 1000 w.

*16089. The Accident at the Blackfriars Sub-Station. L. E. S. Co. Ill. (E E L–Sept. 15.) 700 w.

*16122. New Shunt Arc Lamp. Ill. (E R L–Sept. 15.) 1000 w.

*16125. Electric Lighting of San Carlos Do Pinhal (E R L–Sept. 15.) 550 w.

16158. The New Brush 125-Arc Light Machine. Ill. (E E N Y–Sept. 27.) 450 w.

16161. The Incandescent Lamp Cases (E W–Sept. 30.) 1500 w.

16377. Direct Connected Dynamos with Steam Engines. John Langton (C E N–Oct.) 2400 w.

*16431. The Electric Light as a Lighthouse Illuminant. Editorial (Inv–Sept. 30.) 2000 w.

*16455. New Lamps for Old. W. E. Ayrton, and Editorial (El–Sept. 29.) 3600 w.

*16469. Three Point Incandescent Switches. Ill. Albert Scheible (E I–Oct.) 1000 w.

Serials.

6709. Electric Light and Power. Arthur F. Guy (E E L–Began Sept. 9, 1892—31 parts to date—30 cts. each).

14433. The Incandescent Lamp and its Use. Ill. Gilbert S. Ram (El–Began July 7—13 parts to date—30 cts. each).

15312. Arc Lamps at the World's Fair. Ill. (E W–Began Aug. 26—3 parts to date—15 cts. each).

16399. Electric Light, Thermal Storage, and Utilization of Town's Refuse. C. C. Keep (I & I–Began Sept. 29—1 part to date—30 cts).

GAS ENGINEERING.

*15802. The Inventor of Gas Lighting. William Fletcher (E Mag–Nov.) 3000 w.

*15805. The Use of Producer-Gas for Drying and Roasting Ore. Willard S. Morse (I & S–Sept. 2.) 1000 w.

15893. Hydrogen Gas by the "Hawkite" Process (P A–Sept. 15.) 1700 w.

*15897. Small Gas Undertakings and Differential Prices. Norton H. Humphrys (J G L–Sept. 5.) 2500 w.

*16012. The Advantages of Gas for Cooking and Heating. (Abstract.) C. F. Schweickhurt (J G L–Sept. 12.) 1800 w.

*16115. The French Presidential Address for 1893. M. M. P. Mallett (G W–Sept. 16.) 3000 w.

*16116. Purification of Coal Gas, with Discussion. J. G. Hawkins (G W–Sept. 16.) 3500 w.

16165. Anhydrous Ammonia Gas as a Motive Power. Ill. T. Waln Morgan Draper (Ir Age–Sept. 28.) 2500 w.

*16170. The Utilization of Town Refuse for Fuel or Gas Making (J G L–Sept. 19.) 2200 w.

*16200. Some Points in Gas Engines. W. H. Booth (E L–Sept. 22.) 600 w.

16258. The "Fixing" of Water Gas. James M. Hadden (A G L J–Oct. 2.) 800 w.

*16286. Discussion of W. Stagg's paper, "Notes on the Manufacture of Gas" (G W–Sept. 23.) 3000 w.

16402. Gas Cookers. W. H. Manwaring (A G L J–Oct. 9.) 3000 w.

*16432. The Duty of Gas Companies in Respect of Stoves. G. (G W–Sept. 30.) 1200 w.

*16433. Gas Heating in Hotels, etc. (G W–Sept. 30.) 900 w.

Serials.

13881. Labor Saving Appliances in Gas Works. Ill. (I & I–Began June 16—2 parts to date—30 cts. each).

15534. Purifiers for Small Works (P A–Began Sept. 1—2 parts to date—15 cts. each).

15535. The Development of Ignition Devices for Gas Engines. Ill. G. Lieckfeld (P A–Began Sept. 1—2 parts to date—15 cts. each).

HYDRAULICS.

15868. On Water Measurements and Schinzel's Ebonite Water-Meter. Friedrich Lux (S V–Sept. 15.) 1500 w.

15875. Municipal Acquirement of the Plant of the Syracuse Water Co. Stephen E. Babcock (E N–Sept. 14.) 2900 w.

†15903. Table for Facilitating Calculations of Velocity and Discharge in Long Pipes Flowing Full (I E–Aug. 12.) 900 w.

15918. High Earthen Dams for Storage Reservoirs. L. J. Le Conte (E R–Sept. 16.) 1600 w.

*15970. Some Problems in Pumping Fluids. Ill. J. Richards (M W–Sept. 8.) 3400 w.

†16002. The Works of the East Jersey Water Company, for the Supply of Newark, N. J. Ill. Clemens Herschel (J N E W–Sept.) 10000 w.

†16003. The Location, Construction and Laying of the 54-Inch Steel Submerged Pipe in Skemateles Lake, for the Syracuse Water Works. Ill. William R. Hill (J N E W–Sept.) 2300 w.

†16004. The Purification of Water by Freezing. Thomas N. Drown (J N E W–Sept.) 2000 w.

16055. Address of Ex-President Benzenburg at the Milwaukee Convention (F W-Sept. 23.) 1500 w.

16068. The Beetaloo Concrete Dam. Ill. (E R-Sept. 23.) 1800 w.

†16150. A Continental Issue. Richard J. Hinton (A-Oct.) 4000 w.

16164. Old and Modern Water Works Machinery. Ill. T. W. Yardley (Ir Age-Sept. 28.) 1200 w.

*16205. The Royal Commission and the London Water Supply. Editorial (Eng L-Sept. 22.) 2000 w.

*16297. The Irrigation Idea and Its Coming Congress. Ill. William E. Smythe (R of R-Oct.) 8800 w.

16363. The Duty of Water for Irrigation in Colorado (E N-Oct. 5.) 1000 w.

16364. Irrigation Works on the Crow Indian Reservation, Montana. Ill. (E N-Oct. 5.) 500 w.

16374. Turbine Water Wheels, with Discussion. A. C. M'Callum (C E N-Oct.) 4500 w.

16405. The Storage and Bondage of Water. (Abstract.) J. B. Frizell (E R-Oct. 7.) 1400 w.

16407. Covered Service Reservoirs. (Condensed.) Samuel Tomlinson (E R-Oct. 7.) 2900 w.

*16451. The Water Supply of the Metropolis. Editorial (E-Sept. 29.) 4300 w.

16466. Experience with Deep Wells. F. A. W. Davis (F W-Oct. 7.) 1350 w.

Serials.

15531. The Elements of Tank Construction (I E-Began July 29—3 parts to date—45 cts. each).

15562. Artesian Wells. Oscar C. S. Carter (J F I-Began Sept.—2 parts to date—45 cts. each).

16028. About Siphons. Ill. Leicester Allen (A M-Began Sept. 21—1 part to date—15 cts).

16057. Artesian Wells as a Source of Water Supply. Erastus G. Smith (F W-Began Sept. 23—2 parts to date—15 cts. each).

16338. Hydromechanics. Frank J. Roth (S E-Began Sept.—1 part to date—15 cts).

INDUSTRIAL CHEMISTRY.

15937. How Chemistry Is Best Taught. Charles F. Mabery (Sc-Sept. 8.) 4500 w.

15963. Testing White Lead (Reprint from Painting and Decorating.) (A G L J-Sept. 18.) 2600 w.

†16418. The Development and Extent of the Fertilizer Industry. Charles U. Shepard (J A C S-June.) 5000 w.

Serials.

15995. Explosives and Explosive Materials. Leicester Allen (T-Began Sept. 15—2 parts to date—15 cts. each).

INDUSTRIAL SOCIOLOGY.

15745. Arbitration. Joseph Parkes (A S-Sept. 9.) 1300 w.

*15795. Canada and Our New Tariff. Erastus Wiman (E Mag-Nov.) 3000 w.

*15796. The Value of Labor Statistics. Carroll D. Wright (E Mag-Nov.) 3000 w.

*15799. The History of Strikes in America. —I. Arthur A. Freeman (E Mag-Nov.) 4500 w.

15884. The Prevention of Strikes. A. G. R. and Editorial (R G-Sept. 15.) 1500 w.

*15989. The Employer's Liability Bill.—Full Text of the Measure (R R L-Sept. 8.) 2000 w.

*16018. Child Laborers and Their Protection in Germany. Wilh. Stieda (Ch-Oct.) 2800 w.

16050. The Relation of the Workman to His Foreman. C. A. Burton (F D-Sept. 10.) 1800 w.

†16060. Public Business and the Right to Steal. Isaac L. Rice (F-Oct.) 2800 w.

†16061. Cheaper Living and the Rise of Wages. Carroll D. Wright (F-Oct.) 2500 w.

*16109. The Trades Union Congress, 1893. Editorial (E-Sept. 15.) 2000 w.

†16183. Compensation to the Services. A. Ewbank (I E-Aug. 26.) 400 w.

*16202. Economic Science and Statistics. (Abstract.) Joseph S. Nicholson (Eng L-Sept. 22.) 3700 w.

†16255. The Coming Tariff Legislation. Benton McMillin, John Dalzell, William J. Bryan (N A R-Oct.) 5800 w.

†16257. The Peons of the South. George K. Holmes (An A A-Sept.) 3500 w.

*16339. Sir George Dibbs on the Land Laws of New South Wales, with Editorial (A P R-Aug. 19.) 3800 w.

*16342. The Economic Woman. Wilbur Aldrich (S Ec-Oct.) 2700 w.

16343. Reminiscences of Hon. Abram S. Hewitt Concerning Capital and Labor (B I S-Oct. 4.) 1400 w.

*16350. Prof. Nicholson on the State and the Individual (J G L-Sept. 26.) 2500 w.

*16351. A Projected Coal Trust (J G L-Sept. 26.) 4000 w.

LANDSCAPE ENGINEERING.

15787. A Report upon the Landscape Architecture of the Columbian Exposition, to the American Institute of Architects. Frederick Law Olmsted (A A-Sept. 9.) 6000 w.

16166. American Parks —Lincoln Park, Chicago. M. C. Robbins (G & F-Sept. 27.) 1800 w.

†16196. Frederick Law Olmsted. Ill. Mrs. Schuyler van Rensselaer (C M-Oct.) 6800 w.

MARINE ENGINEERING.

*15743. The Wear and Tear of Ballast Tanks. A. K. Hamilton (S L-Sept.) 2000 w.

*15754. Docks at Liverpool (I C B-Sept. 1.) 500 w.

*15758. Is Marseilles Doomed? (Tr-Sept. 1.) 900 w.

*15791. The Docks of Glasgow (M E-Sept. 1.) 2000 w.

*15792. Mr. Vanderbilt's Yacht "Valiant" (M E-Sept. 1.) 2000 w.

*15800. The Newest War Ships of the United States Navy. W. H. Jaques (E Mag-Nov.) 3000 w.

*15825. Beam Engines for Paddle Steamers (E-Sept. 1.) 1400 w.

*15830. The Port of Venice.—The Improvement of the Side Entrance. Cesare Spadone (E-Sept. 1.) 1800 w.

15883. To Remove Derelicts (Sea-Sept. 14.) 2000 w.

15891. Imported Yachts. Martin P. Hayes. (Reprint from the Illustrated American) (Am S-Sept. 14.) 900 w.

*15895. The Technical Relationship of Shipowners and Shipbuilders. Report of paper by A. Denny (E G-Sept.) 3000 w.

†15901. Dover Harbor Works (I E-Aug. 12.) 3300 w.

15906. Southern Commercial Enterprise.—Inauguration of the Steamship Service of the Chesapeake and Ohio Company. Ill. (M R C-Sept. 14.) 1500 w.

15948. Canada and her Canals to the Seaboard. (Reprint from N. Y. Sun) (M Rec-Sept. 14.) 900 w.

15949. On the Resistance of Water (M Rec-Sept. 14.) 1000 w.

15950. Rudimentary Steps in Steamship Construction (M Rec-Sept. 14.) 1100 w.

*15959. Economical Speed of Steamships. W. J. Millar (E-Sept. 8.) 750 w.

*15976. Jet Propulsion. Editorial (Eng L-Sept. 8.) 2000 w.

16034. Port Los Angeles Wharf. Ill. (R G-Sept. 22.) 500 w.

16042. Steel Boats (M N-Sept. 15.) 350 w.

*16067. Modern Steamship Machinery.—Review of "Modern Steamship Machinery, from First to Last," by J. W. C. Haldane (M-Sept. 15.) 2000 w.

*16081. Scott's Voyage in the Lighthouse Yacht. Robert Louis Stevenson (Sc M-Oct.) 7200 w.

*16108. The Economical Speed of Steamships. Y. Wadagaki (E-Sept. 15.) 1000 w.

*16111. The Waste of Shipping. Editorial (E-Sept. 15.) 2200 w.

*16119. British Trade with China.—A Review of the Ports (Tr-Sept. 15.) 2500 w.

16192. Drinking Water Distilled at Sea.—Baird's Process. Ill. (Eng-Sept. 30.) 900 w.

†16194. Plague in a Pleasure Boat. Ill. J. Stuart Stevenson (C M-Oct.) 4000 w.

*16242. Proposed New Form of Atlantic Greyhound. Ill. (E Rev-Sept. 20.) 400 w.

*16243. The Atlantic—Past and Present (E Rev-Sept. 20.) 2200 w.

†16256. Inland Waterways.—Their Relation to Transportation. Emory R. Johnson (An A A-Sept.) 4800 w.

*16266. Steamships and Their Machinery (Tr-Sept. 22.) 2000 w.

16316. American Domestic Water Commerce. Editorial (A S-Sept. 30.) 700 w.

16348. Two Modern Methods of Introducing Feed Water into Marine Boilers. Ill. (Ir Age-Oct. 5.) 1200 w.

16370. The Variation of the Compass in Magnetic Declination (M Rec-Oct. 5.) 900 w.

16386. Canoeing in America. Ill. Lee J. Vance (Cos-Oct.) 4200 w.

*16447. Shipping Enterprises in the Netherlands (Tr-Sept. 29.) 550 w.

*16448. Mersey Docks Board (Tr-Sept. 29) 600 w.

Serials.

12250. Capt. Alex. McDougall's Patents. Ill. (M R C-Began April 20—15 parts to date—15 cts. each).

14237. The Theory of the Mechanical Propulsion of Ships. Gavin J. Burns (S L-Began July—4 parts to date—30 cts. each).

15277. The First Steam Screw Propeller Boats to Navigate the Waters of Any Country. Francis B. Stevens (Eng-Began Aug. 19—Ended Sept. 16—3 parts—15 cts. each).

15807. Shipbuilding in America (Eng L-Began Sept. 1—3 parts to date—30 cts. each).

MECHANICAL ENGINEERING.

*15752. Cranes and Chains (I C B-Sept. 1.) 900 w.

*15785. The Future of Typewriting. R. T. Nicholson (Inv-Sept. 2.) 2000 w.

15845. Wet Grinding. T. Duncan Paret (M & B-Aug.) 850 w.

15851. A Rotary Mercurial Air Pump. Ill. F. Shulze-Berge (E W-Sept. 16.) 1600 w.

15865. Making Wheels in Halves. Ill. P. S. Dingey (A M-Sept. 14.) 1800 w.

15871. Centrifugal Force as Applied to Revolving Machinery. Ill. G. D. Hiscox (S V-Sept. 15.) 2000 w.

15872. The Collection of Dust Produced in Workshops. Ill. R. Kohfahl (Ir Age-Sept. 14.) 1500 w.

*15955. Stoney's Tipping Crane. Ill. (E-Sept. 8.) 850 w.

*15971. Loose Pulleys (M W-Sept. 8.) 1000 w.

*15974. The Manufacture of Lead Pencils (Eng L-Sept. 8.) 2500 w.

*16294. Stupendous Stone Breaking. Ill. (L E-Oct.) 1000 w.

16320. The Development of Electric Machine Tools. Ill. S. S. Wheeler (E E N Y-Oct. 4.) 2800 w.

16321. Making a Cast Chain. Ill. I. Whitehead (A M-Oct. 5.) 500 w.

16322. Development of a Curved Surface.—A Practical Problem. Ill. Frederic R. Honey (A M-Oct. 5.) 700 w.

16323. The Origin of the "Apron Feed"

Mechanism for Lathes, and the "Swiveling Bearing" for Line Shafting. W. F. Durfee (A M–Oct. 5.) 900 w.

†16389. Anti-Friction Ball Bearings and Their Manufacture. Ill. George F. Simmonds (J F I–Oct.) 2300 w.

Serials.

14879. The Battle of the Typewriters. Ill. (Inv–Began July 29—4 parts to date—30 cts. each).

16428. A New Method of Designing Wheel Teeth. Ill. Archibald Sharp (M W–Began Sept. 29—1 part to date—30 cts).

METALLURGY.

15770. A Metrical System of Weights and Measures with American or English Units and Suited to the Iron and Steel Trades. Walter J. May (A M & I W–Sept. 8.) 1000 w.

15772. German Economy in By-Products of Coke (A M & I W–Sept. 8.) 900 w.

15773. Lead and Its Alloys (M G–Sept. 9.) 1200 w.

*15813. The Separation of Blende from Pyrites. W. P. Blake (C G–Sept. 1.) 750 w.

*15815. The Utilization of Fine Iron Ores. Walter J. May (C G–Sept. 1.) 1700 w.

*15839. Engineers of To-Day and Yesterday. Sir Henry Bessemer. Ill. (E Rev–July 20.) 3600 w.

*15898. The Future of Aluminium (Pl D–Sept.) 1200 w.

15908. The Exhibit of the Canadian Copper Company. Ill. D. H. Browne (E M J–Sept. 16.) 2500 w.

*15968. Employer's Liability in the Iron Industry. Editorial (I C T–Sept. 8.) 1200 w.

*15988. Mixed Hematite Ores for Smelting. Walter J. May (C G–Sept. 8.) 1700 w.

16000. Two Curious Metals (I I G–Sept.) 950 w.

16001. All about Aluminum (I I G–Sept.) 1000 w.

16087. Aspects and Prospects of Copper.—Reprint from N. Y. Tribune (M G–Sept. 23.) 900 w.

16097. Uncle Sam's Gold. — Interesting Treasures Belonging to the Government (B J C–Sept. 23.) 1500 w.

16114. Variations in the Milling of Gold Ores.—Shoes and Dies. T. A. Rickard (E M J–Sept. 23.) 2800 w.

*16131. The Race Between England and the United States.—Iron Competition (I C T–Sept. 15.) 1200 w.

16169. Addresses before the Ways and Means Committee, Sept. 11. W. R. Stirling, J. G. Battelle, W. C. Cronemeyer (B I S–Sept. 27.) 8000 w.

16172. Gold in Ocean Water. (Extract.) T. A. Rickard (M S P–Sept. 23.) 800 w.

16185. Smelting Works in Peru. (Abstract.) Arthur L. Pearse (E M J–Sept. 30.) 600 w.

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16289. Boiler Inspection.—A Commencement Made under State Supervision. R. R. Wade (B J C-Sept. 30.) 2500 w.

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*16325. Recent Improvements in Water Valves. Ill. J. Richards (I S F-Oct.) 900 w.

16346. The Buckeye Triple-Expansion Four Cylinder Engine. Ill. (Ir Age-Oct. 5.) 2800 w.

16381. Inspecting the Boiler. James F. Hobart (M N-Oct. 1.) 1200 w.

†16387. Thermal Analysis of a "Tandem" Compound Engine. Ill. R. H. Thurston (J F I-Oct.) 3300 w.

*16392. The Testing of Boilers.—Discussion of paper by J. Livesey (P Eng-Sept. 29.) 3600 w.

*16393. Smoke Abatement.—Report of the Glasgow and West of Scotland Association (P Eng-Sept. 29.) 1600 w.

16412. Use of Coal Oil in Steam Boilers. W. A. Doble (R R-Oct. 7.) 1000 w.

16422. Engines at the World's Fair.—Some Special Features (B J C-Oct. 7.) 1200 w.

16423. Engine Failures.—Some Interesting Cases Considered (B J C-Oct. 7.) 1300 w.

16440. Piston Valves (R M M-Oct.) 700 w.

Serials.

11138. Notes on the Steam Injector. Strickland L. Kneass (E M-Began March—8 parts to date—30 cts. each).

13033. Practical Hints to Boilermakers and Templaters Ill. (M W-Began May 12—3 parts to date—30 cts. each).

14040. The Steam Engine (T-Began July 1—6 parts to date—15 cts. each).

15303. Steam-Heating Plant for Northern Pacific Railroad Shops. Ill. (E R-Began Aug. 19—3 parts to date—15 cts. each).

15694. The Graphical Determination of Weights of Fly-Wheels of Steam Engines. Emil Theiss (A M-Began Sept. 7—2 parts to date—15 cts. each).

15916. Tools and Appliances for the Steam Hammer. Ill. Joseph Horner. (P Eng-Began Sept. 8—2 parts to date—30 cts. each).

16408. Steam Plant in the New Netherland Hotel. Ill. (E R-Began Oct. 7.—1 part to date—15 cts).

16464. Burning Coal to Make Ice. W. H. Wakeman (M G–Began Oct. 7—1 part to date—15 cts).

TELEPHONY AND TELEGRAPHY.

†15751. An Investigation of the Excursion of the Diaphragm of a Telephone Receiver. Ill. Charles R. Cross and Arthur N. Mansfield (T Q–April.) 2800 w.

*15896. Proposed Section of the Main Pacific Cable (E G–Sept.) 1000 w.

*15926. Ocean Telephony (El–Sept. 8.) 1600 w.

16022. Long Distance Telephony. Ill. J. Anizan (E E N Y–Sept. 20.) 900 w.

*16123. Ocean Telegraphy (E R L–Sept. 15.) 600 w.

*16199. The Antiquity of the Telephone (E L–Sept. 22.) 500 w.

*16227. Hooper's Core for Submarine Cables. Ill. (E R L–Sept. 22.) 2300 w.

16373. Some of the Causes of Interruption to Telegraph Circuits. F. C. Robinson (C E N–Oct.) 2000 w.

16375. History of the Telephone in Canada. L. B. McFarlane (C E N–Oct.) 1800 w.

Serials.

15969 Telegraph Construction Work in East Africa. Rudolph Krausse (E L–Began Sept. 8—2 parts to date—30 cts. each).

MISCELLANEOUS.

15746. The Louisiana Oyster Beds. F. C. Zacharie (M R–Sept. 8.) 4200 w.

15774. Technical Education in the United States (M G–Sept. 9.) 1800 w.

*15803. The Business of Advertising. Ernest H. Heinrichs (E Mag–Nov.) 3000 w.

*15804. The Widening Use of Compressed Air. W. P. Pressinger (E Mag–Nov.) 3000 w.

*15831. Artistic Homes. Ill. Frederick Parsons (B & D–Aug.) 1500 w.

†15857. The Malay Peninsula. Alfred Keyser (N C–Sept.) 6500 w.

†15859. England's Right to the Suez Shares. Cope Whitehouse (F R–Sept.) 3000 w.

15909. The Fertilizer Manufacture in Georgia. W. M. Brewer (E M J–Sept. 16.) 500 w.

15912. The "Pará Rubber" of Bolivia and Peru. Hawthorne Hill (I R W–Sept. 15.) 3000 w.

15913. The Rubber Industry in France. E. Chapel (I R W–Sept. 15.) 1400 w.

15914. The Gutta-Percha Industry in Siam. J. B. Breuer (I R W–Sept. 15.) 900 w.

*15931. Hot-Water Fitting. Ill. Plumbing Iron (I C B–Sept. 8.) 2000 w.

15945. The Chicago Exhibition and Its Successor. Edward Atkinson. (Reprint from N. Y. World) (A A–Sept. 16.) 3500 w.

15946. The Midway Plaisance and Its Attractions (A A–Sept. 16.) 1800 w.

*15965. The Formation of the Earth's Crust and Its Destruction. Henry Aitken (I C T–Sept. 8.) 1900 w.

*15981. Topographical Surveying in America (A L–Sept. 8.) 2600 w.

15999 Transportation to, and from, and on, the World's Fair Grounds. Ill. (S R G–Sept. 16.) 5500 w.

†16006. An Examination of Glyptodendron and of Other So-Called Silurian Land Plants from Ohio. Ill. Aug. F. Foreste (A G–Sept.) 2500 w.

†16007. "The Correct Succession of the Ozark Series"; A Review Reviewed. Frank L. Nason (A G–Sept.) 2300 w.

†16008. Glacial Erosion. Ralph S. Tarr (A G–Sept.) 2000 w.

†16009. A Classification of Topographic Forms. Stuart H. Perry (A G–Sept.) 2000 w.

†16010. On a Collection of Tertiary Mammals from Southern France and Italy; with Brief Descriptions Thereof. John Eyerman (A G–Sept.) 1200 w.

†16014. College of Science, Poona. A. W. T. (I E–Aug. 19.) 3000 w.

*16017. From Bremen to Christiania. Ill. John H. Vincent (Ch–Oct.) 2800 w.

16029. The Change from Gas to Liquid. Ill. F. R. Honey (A M–Sept. 21.) 2500 w.

16030. The Beginning of Economy in Air Compression. Frank Richards (A M–Sept. 21.) 1350 w.

†16045. Household Arts at the World's Fair. Frederick A. Fernald (P S M–Oct.) 4200 w.

†16059. The Downfall of Certain Financial Fallacies. David A. Wells (F–Oct.) 8200 w.

†16062. Rise and Doom of the Populist Party. Frank B. Tracy (F–Oct.) 4400 w.

†16063. The True Significance of Western Unrest. Charles S. Gleed (F. Oct.) 3900 w.

16064. The Last Land Grab. James Danforth (B C–Sept. 23.) 850 w.

*16079. The Northwest Mounted Police of Canada. Ill. J. G. A. Creighton (Sc M–Oct.) 8300 w.

*16080. Historic Houses of Washington. Ill. Teunis S. Hamlin (Sc M–Oct.) 6000 w.

16085. The By-Products of Saw-Milling. Reprint from Hardwood (M R–Sept. 22.) 1600 w.

*16095. Contractors as Consultants. Editorial (I & I–Sept. 15.) 2000 w.

*16141. The Teaching of Technics. W. J. Eden Crane (I C B–Sept. 15.) 1200 w.

†16144. Erosion of River Banks on the Mississippi and Missouri Rivers. Ill. J. A. Ockerson (T C E–June.) 1800 w.

†16148. A Ready Financial Relief. W. H. Van Ornum (A–Oct.) 3000 w.

†16149. Silver or Fiat Money, Which Shall It Be? A. J. Warner (A–Oct.) 3200 w.

†16151. Scotch Banking. J. Shield Nicholson (J P E–Sept.) 5000 w.

†16152. Has the Standard Gold Dollar Appreciated? Simon Newcomb (J P E–Sept.) 3000 w.

†16153. The Economic Condition of Spain in the Sixteenth Century. Bernard Moses (J P E–Sept.) 7000 w.

†16154. The Silver Debate of 1890. Robert F. Hoxie (J P E–Sept.) 18000 w.

16174. The Uses of Logarithmic Cross-Section Paper. Ill. W. F. Durand (E N–Sept. 28.) 4000 w.

16189. Suburban Homes of London. (Reprint from Tribune.) (A & B–Sept. 30.) 1600 w.

†16197. The Pratt Institute. Ill. James R. Campbell (C M–Oct.) 7000 w.

*16204. Commercial and Industrial Undertakings in China (Eng L–Sept. 22.) 900 w.

16213. Address of O. Chanute Before the Conference on Aerial Navigation (Aer–Oct.) 3000 w.

16214. On the Problem of Aerial Navigation. C. W. Hastings (Aer–Oct.) 6000 w.

16215. The Secret of Soaring. Frank H. Winston (Aer–Oct.) 4200 w.

*17241. Engineers of To-Day and Yesterday.—David Kirkaldy. Ill. (E Rev–Sept. 20.) 2500 w.

*16269. The Rio Grande do Sul (Tr–Sept. 22.) 1200 w.

*16278. The Watkin Tower at Wembley. Editorial (I & S–Sept. 23.) 900 w.

*16285. Spontaneous Combustion. Vivian B. Lewes (G W–Sept. 23.) 2800 w.

*16298. The Evils of An Appreciating Currency. Edward B. Howell (R of R–Oct.) 3000 w.

*16327. Fluid Fuel, with Discussion. Ill. Admiral Selwyn (I S F–Oct.) 3600 w.

*16341. Path to Safe Banking and Currency. George Gunton (S Ec–Oct.) 2400 w.

16384. Old Newport. Ill. Ormond Tiffany (Cos–Oct.) 4000 w.

16385. Notes on Ancient Rome. Ill. Rodolfo Lanciani (Cos–Oct.) 3500 w.

*16398. The Camphor Industry of Japan. Ill. (I & I–Sept. 29) 1200 w.

†16429. Compressed Air in Engineering. Leicester Allen (M W–Sept. 29.) 1250 w.

Serials.

13620. One Way to See the Exposition. Ill. Fred De Land (W F E E–Began June—Ended Sept.—4 parts—30 cts. each).

13998. Future of the Hot Air Furnace. A. W. Glessner (Met W–Began July 1—15 parts to date—15 cts. each).

14236. The Science of Success. George W. Buckwell (S L–Began July—Ended Sept.—3 parts—30 cts. each).

14792. The Steering of Balloons. Ill. Rudolphe Soreau (A E R J–Began Aug.—3 parts to date—30 cts. each).

15302. Timber Physics (E R–Began Aug. 19—3 parts to date—15 cts. each).

15433. British Colonies at Chicago (E–Began Aug. 18—4 parts to date—30 cts. each).

15559. Carborundum: Its History, Manufacture and Uses. E. G. Acheson (J F I–Began Sept.—Ended Oct.—2 parts—45 cts. each).

15571. Painting and Sculpture at the World's Fair. H. O. Payne (I A–Began Aug.—2 parts to date—45 cts. each).

16290. The Atmosphere as a Medium of Travel. F. W. Brearey (I & I–Began Sept. 15—3 parts to date—30 cts. each).

16434. The Flash-Point and Heat of Burning of Mineral Oils. D. R. Steuart (G W–Began Sept. 30—1 part to date—30 cts).

16460. The Great Exhibition Reviewed. P. B. Wright (A A–Began Oct. 7—1 part to date—15 cts).

THE TECHNICAL INDEX

A CATALOGUE OF LEADING ARTICLES PUBLISHED CURRENTLY IN THE TECHNICAL JOU RNAL OF THE UNITED STATES AND GREAT BRITAIN.

THIS publication has been aptly described as "the greatest step that has been taken in recent years towards systematizing work" for the engineer, the architect, the electrician, the railway manager, and the business man. The list of publications regularly indexed will show that it covers a world-wide range of the best technical literature, and all the articles are so conveniently classified under general headings that within a few minutes an active man can learn of everything that has been published during the month in relation to his special lines of investigation. In short, it is to the practical man just what Poole's celebrated index to periodicals has long been to the literary worker, but with this essential difference,—namely, that in addition to indicating *just where* leading articles have been published, *we undertake to supply copies of the articles themselves.* The unparalleled convenience and economy of this double service can readily be appreciated.

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[In the body of the index only the initials of the journals quoted are given, and these can be readily identified by the following list of periodicals. Other abbreviations are: Ill=Illustrated. w=words.]

THE AMERICAN PRESS.

A .....Arena. *m.* $5 per year. Boston.
AA.....American Architect. *w.* $6. Boston.
Aer.....Aeronautics. *m.* $1. N. Y.
An A A..Annals of Am. Academy of Political and Social Science. *b-m.* $6. Philadelphia.
A An.... American Analyst. *f.* $1. New York.
A Ar.... American Artisan. *w.* $2. Chicago.
A & B....Architecture and Building. *w.* $6. N. Y.
A CJ....Am. Chem. Journal. *b-m.* $4. Baltimore.
A E .....Architectural Era. *m.* $3. New York.
A E R J..Am. Eng. and Railroad Journal. *m.* $3. N.Y.
A G.....Am. Geologist. *m.* $3.50. Minneapolis.
A G L J..Am. Gas Light Journal. *w.* $3. New York.
A H.....Annals of Hygiene. *m.* $2. Phila.
A J Phar.Am. Journal of Pharmacy. *m.* $3. Phila.
A J R A..Jour. R'y. Appliances. *m.* $2. New York.
A M.....American Machinist. *w.* $3. New York.
A M & I W.Am. Man. and Iron World. $4. Pittsburg.
Am A.....American Agriculturist. *m.* $1.50. N.Y.
Am G....American Gardening. *m.* $1. New York.
Am S....American Shipbuilder. *w.* $2. New York.
A & N J..Army and Navy Journal. *w.* $6. New York.
A & N R..Army and Navy Register. *w.* $3. Wash'ton.
A R.....Architectural Record. *q.* $1. New York.
A Rev....Architectural Review. *s-q.* $5. Boston.
A S .....Age of Steel. *w.* $3. St. Louis.
B B.....Brick Builder. *m.* $2.50. Boston.
B C.....Boston Commonwealth. *w.* $2.50. Boston.
B & D...Builder and Dec. *m.* $2. Minneapolis.
B G S....Bul. Am. Geog. Soc. *q.* $5. New York.
B I S....Bul. Am. Iron and St. Asso. *w.* $4. Phila.
B J C....Boston Jour. of Commerce. *w.* $3. Boston.
B & W...Builder and Woodworker. *m.* $1. N. Y.
C.....Compass. *m.* $1. New York.
C A.....Calif. Architect. *m.* $3. San Francisco.
Can A..Canadian Architect. *m.* $2. Toronto.
C & B...Carpentry and Building. *m.* $1. New York.
C E .....Colliery Engineer. *m.* $2. Scranton, Pa.
C E N...Canadian Elec. News. *m.* $1. Toronto.
C Eng....Canadian Engineer. *m.* $1. Montreal.
Ch.....Chautauquan. *m.* $2. Meadville, Pa.
C M.....Century Magazine. *m.* $4. New York.
Cos.....Cosmopolitan. *m.* $1.50. New York.
D E.....Domestic Engineering. *m.* $1. Chicago.
E A.....Electrical Age. *w.* $3. New York.
E E N Y..Electrical Engineer. *w.* $3. New York.
E I.....Electrical Industries. *m.* $3. Chicago.
E M.....Engineering Mechanics. *m.* $2. Phila.
E Mag ...Engineering Magazine. *m.* $3. New York.
E M J....Eng. and Mining Journal. *w.* $5. N.Y.
E N.....Engineering News. *w.* $5. New York.
Eng .....Engineer. *s-m.* $2. New York.
E N Y....Electricity. *w.* $2.50. New York.
E R.....Engineering Record. *w.* $5. New York.
E R N Y..Electrical Review. *w.* $3. New York.
E & R ...Elec. and Railroading. *m.* $1. Boston.
E S W P...Proc. Eng. So. of W. Pa. *m.* $7. Pittsburg.
E W.....Electrical World. *w.* $3. New York.
F .....Forum. *m.* $5. New York.
F D.....The Foundry. *m.* $1. Detroit.
F W.....Fire and Water. *w.* $3. New York.
G & F....Garden and Forest. *w.* $4. New York.
G G M...Goldthwaite's Geograp. Mag. *m.* $2. N. Y.
G R.....Good Roads. *m.* $2. New York.

I A.....Inland Architect. *m.* $5. Chicago.
I Age....Inventive Age. *s-m.* $1. Washington.
Ir Age..Iron Age. *w.* $4.50. New York.
I I G.....Iron Ind. Gazette. *m.* $1.50. Buffalo.
I R W...India Rubber World. *m.* $3. New York.
I S F.....Industry. *m.* $2. San Francisco.
I T R....Iron Trade Review. *w.* $3. Cleveland.
J A .. ..Journal of Architecture. *m.* $2. Phila.
J A C S..Jour. Am. Chem. So. *m.* $5. Easton.
J A E S..Jour. Assoc. Eng. Soc. *m.* $3. Chicago.
J F I.....Jour. Franklin Institute. *m* $5. Phila.
J M S I..Jour. Milit. Service In. *b-m.* $4. NewYork.
J N E W.Jour. N. E. Waterw. As. *q.* $2. New London.
J P E.....Jour. Polit. Economy. *q.* $3. Chicago.
J U S A..Jour. U. S. Artillery. *q.* $2.50. Ft. Monroe.
L E.....Locomotive Engineering. *m.* $2. N. Y.
L Mag...Lippincott's Magazine. *m.* $3. Phila.
M & B...Manufacturer and Builder. *m.* $1.50. N. Y.
M & El...Mech. and Electrician. *w.* $2. St. Louis.
Met W...Metal Worker. *w.* $2. N. Y.
M G.....Manufacturer's Gazette. *w.* $2.50. Boston.
Min.....Minerals. *m.* $1. N. Y.
Min. R...The Mining Review. *w.* $2. Denver.
M I T....Mining Industry. *w.* $3. Denver.
M N.....Mechanical News. *s-m.* $1.50. New York.
M R.....Manufacturer's Record. *w.* $4. Baltimore.
M R C...Marine Review. *w.* $2. Cleveland, O.
M Rec....The Marine Record. *w.* $2. Cleveland.
M S P....Min. and Sci. Press. *w.* $3. San Francisco.
M S R....Mining and Sci. Review. *w.* $2. Denver.
N A R...North American Review. *m.* $5. N. Y.
N B .....National Builder. *m.* $3. Chicago.
N C B...National Car Builder. *m.* $2. New York.
N P R...Nat. Popular Review. *m.* $2.50. Chicago.
N W.....Nowest. Architect. *m.* $3. Minneapolis.
O P D R..Oil, Paint and Drug Reporter. *w.* $6. N.Y.
P.....Paving. *m.* $2. Indianapolis.
P A.....Progressive Age. *s-m.* $3. New York.
P D.. ...Painting and Decorating. *m.* $1. Phila.
P E.....Practical Electricity. *f.* $2. Boston.
P S.....Power-Steam. *m.* $1. N. Y.
P S M....Popular Science Monthly. *m.* $5. N. Y.
R A.....Railway Age. *w.* $4. Chicago.
R C J....Railroad Car Journal. *m.* $1. New York.
R G .....Railroad Gazette. *w.* $4.20. N. Y.
R M.....Roller Mill. *m.* $2. Buffalo, N. Y.
R M M..Railway Master Mechanic. *m.* $1. Chicago.
R of R...Review of Reviews. *m.* $2.50. New York.
R R.....Railway Review. *w.* $4. Chicago.
R & T...Roofer and Tinner. *m.* $1. N. Y.
R'y N....Railway News. *m.* $2. New York.
S... .....Stone. *m.* $2. Indianapolis, Ind.
S A.....Southern Architect. *m.* $2. Atlanta.
San.....Sanitarian. *m.* $4. Brooklyn.
Sc.....Science. *w.* $3.50. New York.
Sc A ....Scientific American. *w.* $3. New York.
Sc A S ...Scientific Am. Supplement. *w.* $5. N. Y.
Sc M....Scribner's Magazine. *m.* $3. New York.
S E .....Stationary Engineer. *w.* $2. Chicago.
Sc Q.....Scientific Quarterly. *q.* $2. Golden, Cal.
Sea.....Seaboard. *w.* $2. New York.
S Ec.....Social Economist. *m.* $2. New York.
S J E....Sibley Jour. of Eng. *m.* $2. Ithaca, N. Y.
S M.....ScientificMachinist.*s-m.*$1.50. Cleveland,O.
So L.....Sou. Lumberman. *s-m.* $2. Nashville.
S M Q....School of Mines Quarterly. $2. N. Y.
S R E N..St. R'y. Elec. News. *m.* $2. Minneapolis.
S P.....Sanitary Plumber. *s-m.* $1. New York.
S R G....Street Railway Gazette. *w.* $3. Chicago.
S R J....Street Railway Journal. *m.* $4. New York.
S R N. ..Street Railway News. *w.* $3. New York.
S R R. ..Street Railway Review. *m.* $2. Chicago.
S S.....Southern States. *m.* $1.50. Baltimore.
S V.....Safety Valve. *m.* $1. New York.
T.....Tradesman. *s-m.* $2. Chattanooga, Tenn.
T A I E E.Trans. Am. Ins. Elec. Eng. *m.* $5. N. Y.
T C E....Trans. Am. Soc. Civil Eng. *m.* $10. N. Y.
T Q.....Technology Quarterly. $3. Boston.
W E.. ...Western Electrician. *w.* $3. Chicago.
W F E E.World's Fair Elec. Eng. *m.* $3. Chicago.
W G R..Water and Gas Review. *m.* $1. New York.

THE FOREIGN PRESS.

A L.....The Architect. *w.* 26*s.* London.
A M S..Aust. Mining Standard. *w.* 30*s.* Sydney.
A P R...Aus. Pastoralists' Rev. *m.* 30*s.* Sydney.
B A... .The British Architect. *w.* 23*s.* 8*d.* London.
C G.. ..Colliery Guardian. *w.* 27*s.* 6*d.* London.
C R .....Contemporary Review. *m.* $4.50. London.
C T J....Chem. Trade Jour. *w.* 12*s.* 6*d.* Manchester.
D.....Discovery *w.* 8*s.* 8*d.* London.
E.....Engineering. *w.* 36*s.* London.
E E L....Electrical Engineer. *w.* 17*s.* 4*d.* London.
E G.....Engineers' Gazette. *m.* 4*s.* London.
E L.....Electricity. *w.* 6*s.* 6*d.* London.
El.. .....Electrician. *w.* 24*s.* London.
EngL... Engineer. *w.* 36*s.* London.
E P.....Electrical Plant. *m.* 6*s.* London.
E Rev....Engineering Review. *m.* 7*s.* London.
E R L.....Electrical Review. *w.* 21*s.* 8*d.* London.
F R.....Fortnightly Review. *m.* $4.50. London.
G E M...Gas Engrs' Mag. *m.* 6*s.* 6*d.* Birmingham.
G W.....Gas World. *w.* 13*s.* London.
I .....Iron. *w.* 30*s.* London.
I'& I.....Industries and Iron. *w.* £1. London.
I & S.....Iron and Steel Trades' Jour. *w.* 25*s.* London.
I C B... .Carpenter and Builder. *w.* 8*s.* 8*d.* London
I C T.... Iron and Coal Review.*w.* 30*s.* 4*d.* London.
I E.....Indian Engineering. *w.* 18 Rs. Calcutta.
Inv .....Invention. *w.* 28*s.* London.
J G L....Journal of Gas Lighting. *w.* London.
J S A....Journal of the So. of Arts. *w.* London.
K.....Knowledge. *m.* 6*s.* London.
M.....Machinery. *m.* 9*s.* London.
M E.....Marine Engineer. *m.* 7*s.* 6*d.* London.
M E & E J.Man. Eng. and Export Jour. *m.* London.
Min W..The Mining World. *w.* 21*s.* London.
M W.....Mechanical World. *w.* 8*s.* 8*d.* London.
N..... Nature. *w.* $7. London.
N C.....Nineteenth Century. *m.* $4.50 London.
P Eng...Practical Engineer. *w.* 10*s.* London.
Pl D .....Plumber and Decor. *m.* 6*s.* 6*d.* London.
R N.....Railway News. London.
R P L....The Railway Press. *m.* 7*s.* London.
R R L...The Railway Review. *w.* London.
R W.....Railway World. *m.* $3. London.
S L.....Steamship. *m.* Leith, Scotland.
S R.....Sanitary Record. *m.* 10*s.* London.
Tr.....Transport. *w.* £1. 5*s.* London.
W R.....Westminster Review. *m.* $4.50. London.

ARCHITECTURE.

*16474. Architecture as a Profession. R. W. Gibson (E M–Dec.) 2500 w.

16548. Graphite.—Its Uses and Durability as a Paint. John A. Walker (M & B–Sept.) 1800 w.

16559. Vitruvius and the Modern Architect (A & B–Oct. 14.) 1800 w.

16565. Art Sense and Art Nonsense. Edward Atkinson (A A–Oct. 14.) 3500 w.

*16572. The Problem of National American Architecture. Robert Kerr (A R–Oct.–Dec.) 7500 w.

*16575. The Development of Architecture. Ill. H. W. Desmond (A R–Oct.–Dec.) 4000 w.

*16576. Architects' Houses. Ill. John Beverley Robinson (A R–Oct.–Dec.) 5000 w.

*16577. Architectural Aberrations—The Hale Building, Philadelphia. Ill. (A R–Oct.–Dec.) 2000 w.

*16578. The New York City Hall Competition—A Protest (A R–Oct.–Dec.) 1400 w.

*16584. Excerpts from "The Nature and Function of Art." Leopold Eidlitz (J A–May.) 1000 w.

*16609. The Church of Chester-le-Street. (A L–Oct. 6.) 2800 w.

*16613. The Growth of the Fret. Ill. (Pl D–Oct. 2.) 1500 w.

16656. Making Window-Frames (T–Oct. 15.) 2700 w.

16659. The New System of Construction (R & T–Oct.) 1900 w.

16660. Zinc Roofing in England. W. J. Eden Crane (R & T–Oct.) 1200 w.

*16704. An Extraordinary Contrast. Glém Abaza (A L–Oct. 13.) 1800 w.

*16709. Repainting Old Plaster. A. Posteriori (I C B–Oct. 13.) 1500 w.

*16711. Chimneypieces. (I C B–Oct. 13.) 2600 w.

*16712. Early Decorated Windows (I C B–Oct. 13.) 700 w.

*16713. Xyolith or Wood Stone (I C B–Oct. 13.) 700 w.

*16730. The Spoils of Greece (A L–Oct. 13.) 2900 w.

*16738. A Plea for a Canadian School of Architecture. Charles Baillairge (Can A–Oct.) 4500 w.

16754. Architecture in Apartment-Buildings. F. Adolphe Bocage (A A–Oct. 21.) 1700 w.

16774. Some Western Methods of Cornice Work. Ill. C. H. Argo (Met W–Oct. 21.) 1500 w.

16833. Homes and Remains of the Cliff Dwellers. H. C. Hovey (Sc A–Oct. 28.) 3500 w.

*16839. The Ornamental Treatment of Bricks and Iron. James Naugle (B B–June.) 1600 w.

16851. The Tallest Office-Building in the World—Reprint from N. Y. Times (Eng–Oct. 28.) 550 w.

†16870. The Geography and Architectural Monuments of Medieval Europe. Egbert L. Viele (B Y S–Sept. 30.) 5300 w.

*16876. The Elgin Marbles (A L–Oct. 20.) 2700 w.

*16878. St. Mary's Church, Howth (A L–Oct. 20.) 1100 w.

*16880. Notes on Ancient Temple Architecture. (Abstract.) John M. Hartman (A L–Oct. 20.) 1900 w.

16911. On the Use of Color in Architectural Design. H. Langford Warren (A A–Oct. 28.) 4200 w.

16913. Architects' Charges. Editorial (A & B–Oct. 28.) 1200 w.

16914. English Wall-Papers. Ill. Arthur Seymour Jennings (A & B–Oct. 28.) 3800 w.

16915. Hadrian's Villa (A & B–Oct. 28.) 700 w.

16977. Beckwith Memorial Theatre. Ill. (C & B–Nov.) 700 w.

16978. Joints in Brickwork (C & B–Nov.) 1900 w.

†17013. Workingmen's Model Homes as Shown at the Exposition, and Chicago's Practical Experience in the Same Direction. P. B. Wight (I A–Oct.) 3000 w.

17022. Restorations of the Pantheon. Ill. (Sc A S–Nov. 4.) 500 w.

17069. Mixing and Using Mortar, Cement, Concrete, Stucco and Mastic (T–Nov. 1.) 2500 w.

17091. Efflorescence of Bricks—A Remedy Suggested (B J C–Nov. 4.) 700 w.

†17092. The Broadest Use of Precedent. D. Andrews (A Rev–May 15.) 5000 w.

17102. Legal Points in Practice—Reprint from the Building News (A A–Nov. 4.) 1800 w.

*17105. The Rewards of Art (A L–Oct. 27.) 2000 w.

*17107. Early Glass-Painting (A L–Oct. 27.) 1350 w.

*17108. The Architecture of Chicago—Reprint from Melbourne Argus. (A L–Oct. 27) 300 w.

17170. The New Excavations at Troy—Reprint from The Builder (Sc A S–Nov. 11.) 1200 w.

Serials.

7121. Office Help for Architects. Ill. George Hill (A A–Began Oct. 8, 1892—21 parts to date—15 cts. each).

12568. Building Construction and Superintendence. F. E. Kidder (A & B–Began May 6—13 parts to date—15 cts. each).

13407. Terra Cotta and Faience as Materials for Architectural and Decorative Application (B B—Began April—3 parts to date—30 cts. each).

14370. Wasted Opportunities.—Defects of Office Buildings (A R–Began July-Sept.—2 parts to date—30 cts. each).

16549. Live Loads in Office Buildings C. H. Blackall (N B–Began Oct.—1 part to date—30 cts).

16560. The Burgundian School of Architect-

ure. A. de Baudot (A A-Began Oct. 14—2 parts to date—15 cts. each).

16573. The Lotiform Origin of the Ionic Capital. Ill. William H. Goodyear (A R—Began Oct.-Dec.—1 part to date—30 cts).

16732. An Architect's Library. T. Roger Smith (A L-Began Oct. 13—Ended Oct. 20—2 parts—30 cts. each).

17014. Public Competition of Architecture. J. Gaudet (I A-Began Oct.—1 part to date—45 cts).

17100 Town Halls. Ill. E. Rümler (A A-Began Nov 4—1 part to date—15 cts).

CIVIL ENGINEERING.

*16535. The North Sea—Baltic Canal. Ill. (Eng L-Oct. 6.) 1400 w.

*16605. Tipping Boxes for Depositing Concrete Sacks at La Guaira Breakwater. Ill. (E-Oct. 6.) 950 w.

16642. A Triangulation System for River Surveying. Walter G. Kirkpatrick (E N-Oct. 12.) 900 w.

†16670. Navigation Works Executed in France from 1876 to 1891. F. Guillain (T C E-July.) 2700 w.

†16671. Inland Transportation. F. A. Mahan (T C E-July.) 11500 w.

†16672. History of the Conversion of the River Clyde into a Navigable Water Way, and of the Progress of Glasgow Harbor from Its Commencement to the Present Day. James Deas (T C E-July.) 14500 w.

†16673. Description of the Lower Weser and Its Improvement. L. Franzius (T C E-July.) 6200 w.

†16674. A Brief Account of the Building of Leuxoes Harbor. Alfonso Joaquin Nogueira Soares (T C E-July.) 2400 w.

†16676. The Improvement of Harbors on the South Atlantic Coast of the United States. William Murray Black (T C E-July.) 25200 w.

*16724. New Method for Sinking Shafts through Quicksands and Water-bearing Measures (C G-Oct. 13.) 1200 w.

16765. A German Iron and Ballast Bridge Floor. Ill. (E N-Oct. 19.) 800 w.

16859. The Testing and Use of Portland Cement in Europe (E N-Oct. 26.) 1800 w.

16863 Triangulation in River Surveys. Thomas C. J. Baily, Jr. (E N-Oct. 26.) 750 w.

*16882 Piercing the Alps. The Story of a Great Tunnel (Tr-Oct. 20.) 2200 w.

16920. The Cincinnati Southern Bridge. Ill. (E R-Oct 28.) 700 w.

*16922. The Rue de Tolbiac Bridge, Paris (Eng L-Oct. 20.) 2600 w.

16980. Moving a Brick Railroad Station.—Mott Haven, N. Y. Ill. (C & B-Nov.) 450 w.

†17025 How to Improve Our Roads. Roswell P. Flower (N A R-Nov.) 3500 w.

†17031. Common Roads, Railways and River Communications in Portugal. Frederico Augusto Pimental (T C E-Aug.) 5500 w.

†17042. Continued Discussion of Mr. Estrada's paper on "The Effect of Suddenly Applied Loads Upon the Tensile Strength and Other Physical Properties of Wrought Iron and Steel." (E S W P-Sept.) 3000 w.

17048. The Improvement of the Columbia River (R G-Nov. 3.) 1700 w.

*17057. Portland Cement. Editorial (E-Oct. 27.) 1400 w.

17066. The Tower of the New City Hall at Philadelphia, Pa. (Abstract.) C. R. Grimm (E N-Nov. 2.) 1400 w.

17089. Pile Driving (B J C-Nov. 4.) 800 w.

*17113. Methods and Cost of Street-Cleaning. M. M. Defries (P-Nov.) 1500 w.

*17114. Asphalt and Asphalt Pavements. E. J. De Smedt (P-Nov.) 900 w.

*17115. Telford vs. MacAdam. Which Was Right? Latham Anderson (P-Nov.) 1200 w.

17133. Sewer Tunneling, Cologne, Germany. Ill. (E R-Nov. 4.) 1000 w.

*17151. Country Road Construction—Excerpts from Notes Compiled and Prepared for the State Road Convention of California. Julius Striedinger and Otto von Geldern (I S F-Nov.) 8500 w.

17169. The Mississippi River—The Government Works an Injury and an Obstruction to the Father of Waters. William L. Elseffer (Sc A S-Nov. 11.) 3000 w.

17179. Roads and Streets at the World's Columbian Exposition (E N-Nov. 9.) 3000 w.

17180. The Transverse Strength of Concrete. Ill. Experiments of A. F. Bruce (E N-Nov. 9.) 1500 w.

17182. Chert Roads at Birmingham, Ala. Julian Kendrick (E N-Nov. 9.) 900 w.

17184. Eccentric Loading of Cast Iron Columns. Ill. (E N-Nov. 9.) 850 w.

†17204. Bridging the North Channel of the Irish Sea. Ill. (I E-Oct. 7.) 650 w.

Serials.

8671. MacAdam and Telford Roads. Ill. Isaac B. Potter (G R-Began Nov., 1892—5 parts to date—30 cts. each).

13194. Highway Bridges. Ill. John N. Ostrom (G R-Began May—6 parts to date—30 cts. each).

14704. Brick Pavements (E R-Began July 29—4 parts to date—15 cts. each).

15927. The Contra Costa Road Plan. A. L. Bancroft and C. M. Plumb (G R-Began Sept.—2 parts to date—30 cts. each).

16282. The Tower Bridge. Ill. (E-Began Sept. 22—Ended Oct. 20—5 parts—30 cts. each).

16513. How to Build Good Roads. W. E. McClintock (M S P-Began Oct. 7—Ended Oct. 14—2 parts—15 cts. each).

16520. Plant and Gear Made Locally for the Kistna Bridge. Ill. F. J. E. Spring (I E-Began Sept. 9—2 parts to date—45 cts. each).

16677. Road Work at Flushing. Ill. (G R-Began Oct.—1 part to date—30 cts).

ELECTRICAL MISCELLANY.

*16477. Electric Power at the World's Fair. Ill. Nelson W. Perry (E M–Dec.) 3000 w.

16481. The Shute Memorial Electrical Fountain at Lynn, Mass. (E R N Y–Oct. 14.) 700 w.

16496. Armature Winding for High Tension Multipolar Machines. Ill. W. R. (E E N Y–Oct. 11.) 300 w.

16497. The Western Electric Company at the World's Fair. Ill. (E E N Y–Oct. 11.) 4500 w.

16500. Efficiency Tests of Continuous Current Dynamos and Motors. Frank P. Cox (E W–Oct. 14.) 700 w.

16529. Electrolysis of Underground Pipes, with Editorial. Ill. (E R–Oct. 14.) 2500 w.

*16531. The Propagation of Electric Energy —Review of Book by Heinrich Hertz (N–Oct. 5.) 1000 w.

*16545. The Commercial Production of Ozone. Ill. (C T J–Oct. 7.) 900 w.

*16555. The Routin Electricity Meter. Ill. (E E L–Oct. 6.) 1800 w.

16596. The Influence of Electrical Inventions. Thomas D. Lockwood (W E–Oct. 14.) 4300 w.

16597. Electrical Development in Sweden. N. O. W. Rahm (W E–Oct. 14.) 1300 w.

16598. The Fire Hazard of Electricity. W. H. Merrill, Jr. (W E–Oct. 14.) 1500 w.

16600. Electrical Transmission Abroad. S. P. Thompson (W E–Oct. 14.) 1000 w.

†16601. Discussion of Paper by D. McFarlan Moore, in "A New Method for the Control of Electric Energy" (T A I E E–Oct.) 6200 w.

†16603. Hedgehog Transformer and Condensers. Ill. F. Bedell, K. B. Miller, and G. F. Wagner (T A I E E–Oct.) 4200 w.

*16630. Note on Alternating Currents. Arthur Whitwell (E R L–Oct. 6.) 150 w.

*16632. The Resistance of the Human Body to Interrupted Currents (E R L–Oct. 6.) 1200 w.

*16638. Electric Forging (M W–Oct. 6.) 1800 w.

*16640. A New Accumulator Made of Metallic Lead Dust. Editorial (E L–Oct. 6.) 500 w.

16685. The Chloride Accumulator (E N Y–Oct. 18.) 1200 w.

*16717. Electrolytic Caustic and Bleach. Ill. (E R L–Oct. 13.) 1700 w.

*16718. Electrical Cooking (E R L–Oct. 13.) 1600 w.

*16744. Notes on the E. M. F. and Temperature Coefficients of the Cadmium Mercury Cell. Ill. Arthur Dearlove (El–Oct. 13) 1200 w.

*16745. Polarization of Platinum Electrodes in Sulphuric Acid. Ill. James B. Henderson (El–Oct. 13.) 800 w.

16770. The Chloride Accumulator. Ill. (E E N Y–Oct. 18.) 1500 w.

16777. The Union of Electrical Engineers of Germany (E R N Y–Oct. 21.) 1200 w.

16779. Seeing by Electricity. George H. Morse (E W–Oct. 21.) 750 w.

16780. The Impedance of Mutually Inductive Circuits. A. E. Kennelly (E W–Oct. 21.) 1600 w.

*16793. Cooking by Electricity. Fannie C. W. Barbour (Ch–Nov.) 1500 w.

16812. Electricity ; Its Origin and a Glance at Its Use. H. F. Royce (R R–Oct. 21.) 3000 w.

16835. The Field Quadruplex. Ill. S. D. Field (E E N Y–Oct. 25.) 1400 w.

*16936. The Development of Electric Machine Tools. S. S. Wheeler (El–Oct. 20.) 2500 w.

*16945. Accumulators Up to Date (E R L–Oct. 20.) 1600 w.

*16947. I. Advantages Attending the Multiplication of Electrical Students and Would-Be Electrical Engineers. II. The Necessity for a New Subject of Examination by the City and Guilds of London Institute. W. Perren Maycock (E R L–Oct. 20.) 2000 w.

*16952. The Effect of Water Vapor on Electrical Discharges. J. J. Thompson. (Abstract of Article in Philosophical Magazine.) (N–Oct. 19.) 800 w.

16972. On the Distortions of Fine Wires Conducting Rapidly Oscillating Discharges. A. E. Kennelly (E E N Y–Nov. 1.) 1000 w.

16974. Self-Induction as a Remedy for Static Discharge. Patrick B. Delany (E E N Y–Nov. 1.) 950 w.

16986. The Contract for the Cataract Construction Company (E R N Y–Nov. 4.) 500 w.

17016. Storage Batteries in Commercial Work. J. Arnold (E W–Nov. 4.) 800 w.

17072. French Power Transmission Plant. Ill. (W E–Nov. 4.) 1000 w.

*17082. The Thickness and Electrical Conductivity of Thin Liquid Films. A. W. Reinold (N–Oct. 26.) 3500 w.

*17104. Electrolysis of Sea-Salt (E E L–Oct. 27.) 700 w.

*17130. The LeRoy High Tension Cut-Out. Ill. (E R L–Oct. 27.) 1800 w.

*17139. Series Power Transmission. Ernest Schulz (E L–Oct. 27.) 2000 w.

†17152. The Storage Battery Question. Pedro G. Salom (J F I–Nov.) 5000 w.

17155. An Electric Weighing Machine. Ill. (E N Y–Nov. 8.) 700 w.

17159. Electricity by Water Power.—The Future of the Rocky Mt. States. Oscar Bradford (E R N Y–Nov. 11.) 600 w.

17160. The Station of the Edison Light and Power Company of San Francisco. Ill. (E R N Y–Nov. 11.) 1000 w.

17166. On the Current Strength in Simple Circuits Containing Resistance, Inductance and Capacity Under Periodic Impressed Electromotive Forces of the Rectangular Wave Type. Ill. A. E. Kennelly (E W–Nov. 11.) 900 w.

17178. Electricity at the California Exposition. Ill. (W E-Nov. 11.) 1100 w.

17185. The Tesla Electrical Oscillator. Ill. (E E N Y-Nov. 8.) 1200 w.

Serials.

10464. The Silver Plating Industry. Ill. (I & I-Began Feb. 3—5 parts to date—30 cts. each).

15476. Judging the Electrical Exhibits at the World's Fair. Hermann S. Hering (E W-Began Sept. 2—Ended Oct. 14—5 parts—15 cts. each).

16044. Electricity at the World's Fair. Charles M. Lungren (P S M-Began Oct.—2 parts to date—45 cts. each).

16096. Commercial Magnetism. J. S. (I & I-Began Sept. 15—6 parts to date—30 cts. each).

16228. Electric Supply Companies (E E L-Began Sept. 22—3 parts to date—30 cts. each).

16453. An Examination of Prof. Lodge's Electro Magnetic Hypothesis. Ill. J. H. Poynting (El-Began Sept. 29—Ended Oct. 13.—3 parts—30 cts. each).

16458. Design of Alternating Current Motors. Emil Kolbein (El-Began Sept. 29—Ended Oct. 6.—2 parts—30 cts. each).

16501. The Electrical Features of Milwaukee. Ill. (E W-Began Oct. 14—Ended Oct. 21—2 parts—15 cts. each).

16686. Some Measurements of the Temperature Variation in the Electrical Resistance of a Sample of Copper. A. E. Kennelly and R. A. Fessenden (E N Y-Began Oct. 18—Ended Oct. 25—2 parts—15 cts. each).

16740. Primary Batteries in Theory and Practice. Ill. W. R. Cooper (El-Began Oct. 13—3 parts to date—30 cts. each).

16743. The Potentiometer Method of Measuring the Electromotive Force of Transformers. Ill. Bernard P. Scattergood (El-Began Oct. 13—Ended Oct. 20—2 parts—30 cts. each).

16784. Transformer Testing. Ill. Henry H. Norris (E W-Began Oct. 21—2 parts to date—15 cts. each).

16822. A New Method of Charging for Electric Supply from Central Stations. Otto Frick (E W-Began Oct. 28—2 parts to date—15 c.s. each.

17131. A New System of Alternating Current and Transformer Distribution. Rankin Kennedy (E R L-Began Oct 27—1 part to date—30 cts).

17156. Transformer Diagrams Experimentally Determined. Ill. Frederick Bedell, assisted by A. W. Berresford, W. M. Craft, and B. Gherardi, Jr. (E N Y-Began Nov. 8—1 part to date—15 cts).

17167. Notes on Recent Developments in Electricity Abroad. Carl Hering (E W-Began Nov. 11—1 part to date—15 cts).

ELECTRIC LIGHTING.

16551. The Electric Search Light in Shaft Sinking. James Baird (E M J-Oct. 14.) 400 w.

*16556. Incandescent Lamps from the Private Consumer's Standpoint (E E L-Oct. 6.) 900 w.

*16629. Incandescent Lamps. Editorial. (E R L-Oct. 6.) 1800 w.

*16646. Manchester Municipal Electric Power Station, with Editorial. Ill. (El-Oct. 6.) 4200 w.

*16708. Edinburgh and Electricity. R. Kennedy (G E M-Oct. 10.) 2500 w.

*16720. A Rheostat for Incandescent Lamps. Ill. (E R L-Oct 13.) 650 w.

*16721. High Frequency Discharges and Incandescent Lamps (E R L-Oct. 13.) 650 w.

*16815. Derby Central Station. Ill. (E E L-Oct. 13.) 1400 w.

*16873. Blackpool. Ill. (E E L-Oct. 20.) 4400 w.

*16875. Cook, Smythe, and Payne's Patent Fireproof System of Conductors. Ill. (E E L-Oct. 20.) 900 w.

*16935. Compensating Generators at Derby. Ill. (El-Oct. 20.) 500 w.

*16944. Electric Lighting at Blackpool (E R L-Oct. 20.) 2600 w.

*16946. Arc Lighting.—A Corrected Formula. E. Tremlett Carter (E R L-Oct. 20.) 750 w.

16973. A Safety System of Electric Wiring. Ill. C. J. Kintner (E E N Y-Nov. 1.) 600 w.

16985. World's Fair Light Effects Described by a Woman. Kate Gannett (E R N Y-Nov. 4.) 550 w.

*16997. Preliminary Survey for Electric Light Stations, with Discussion. E. P. Roberts (J A E S-Sept.) 3800 w.

17017. On the Candle Power of Incandescent Lamps (E W-Nov. 4.) 800 w.

*17086. The Artificial Lighting of Workshops. Ill (Abstract.) Benjamin A. Dobson (El-Oct. 27.) 2200 w.

*17125. The Manchester Corporation Electricity Supply. Ill. (I & I-Oct. 27.) 4000 w.

17157. Lamp Bank Rheostats. Ill. C. W. Swoope (E N Y-Nov. 8.) 600 w.

17158. An Electric Light Vessel.—The Only One in the World. Ill. Stephen L. Coles (E R N Y-Nov. 11.) 1500 w.

Serials.

7620. Electric Light and Power. Arthur F. Guy (E E L-Began Oct. 21, 1892—32 parts to date—30 cts. each).

13548. Arc Lighting. Ill. E. Tremlett Carter (E R L-Began June 2—10 parts to date—30 cts. each).

14433. The Incandescent Lamp and Its Manufacture. Ill. Gilbert S. Ram (El-Began July 7—Ended Oct. 20—16 parts—30 cts. each).

16399. Electric Light, Thermal Storage and Utilization of Town's Refuse (I & I-Began Sept. 29—2 parts to date—30 cts. each).

16631. The Scientific Study of Arc Lamps. Ill. Rankin Kennedy (E R L-Began Oct. 6—2 parts to date—30 cts. each).

16741. Lamp Holders. Ill. (El-Began Oct. 13—Ended Oct. 27—3 parts—30 cts. each).

GAS ENGINEERING.

*16619. Gas Supply in the Far East. F. G. Cockey (J G L-Oct. 3.) 2500 w.

*16634. Enrichment of Coal Gas by the Hydro-Oxy Process (G W-Oct. 7.) 3200 w.

16635. On Flame. (Abstract.) Prof. Smithells (A G L J-Oct. 6.) 1400 w.

*16707. Use of Gas in Puddling Iron. John Head (G E M-Oct. 10.) 700 w.

*16773. Four Years' "Progress" of Water Gas. R. S. Moss (J G L-Oct. 10.) 1600 w.

*16801. New Method of Purification. Ill. T. T. Prins (G W-Oct. 14.) 350 w.

*16802. Treatment of Liquids with Gases (G W-Oct. 14.) 1500 w.

*16803. Inaugural Address of D. Terrace (G W-Oct. 14) 2800 w.

16807. Something of Interest in Relation to the Electrolysis of Gas-Pipes. Ill. (A G L J-Oct 23.) 950 w.

*16864. Carburetting Illuminating Gas. H. Bunte (J G L-Oct. 17.) 4200 w.

17119. The Revivification of Iron Oxide. George Treadway (A G L J-Nov. 6.) 3500 w.

17120. Rate of Purification. J. A. P. Crisfield (A G L J-Nov. 6.) 900 w.

17121. Relation of Temperature to Purification, with Discussion of Three Papers on Purification. James Somerville (A G L J-Nov. 6.) 1600 w.

17146. Gas Engines in the United States. Ill. Fred H. Shelton (P A-Nov. 1.) 20000 w.

Serials.

13534. The Gas Engine. Ill. (M W-Began June 2—4 parts to date—30 cts. each).

16610. Gas Substitutes. Vivian B. Lewes (A L-Began Oct. 6—Ended Oct. 13—2 parts—30 cts. each).

HYDRAULICS.

16507. A Novel Water Wheel. Ill. C. L. Redfield (A M-Oct. 12.) 600 w.

16530. The Shirley Gut Siphon. Ill. (E R-Oct. 14) 800 w.

16533. London Water Supply (F W-Oct. 14.) 1400 w.

16534. Receiving Water Under Pressure. W. H. Wakeman (F W-Oct. 14.) 800 w.

†16582. The Balram Das Water Works, Raipur, C. P. B. (I E-Sept. 16.) 2000 w.

16589. Pumping Fluids.—Some Problems in Raising and Impelling Water. Ill. (B J C-Oct. 14.) 2000 w.

†16675. The Limits Attainable in Improving the Navigability of Rivers by Means of Regulation. H. Engels (T C E-July.) 8000 w.

16755 The Hydraulic Works and System of Hydraulic Power-Supply at Geneva. Extracts of lecture by W. C. Unwin (A A-Oct. 21.) 2800 w.

16855. Some Pump Notes.—Size of Suction Pipes and Speed of Pumps (B J C-Oct 28.) 850 w.

†16857. Back-Water of Weirs. G. C. Macouchy (I E-Sept 23.) 2000 w.

16861. The Construction of Reservoir Embankments (E N-Oct. 26.) 1000 w.

16919. The International Irrigation Congress at Los Angeles, Cal. Editorial (E R-Oct. 28.) 800 w.

17077. How Switzerland's Water Power Is Utilized (M R-Nov. 3.) 1000 w.

17088. Water Power.—Extract from lecture by W. C. Unwin (M G-Nov. 4.) 2800 w.

*17096. Old Waterworks Machinery. Ill. (M W-Oct. 27.) 650 w.

17144. An Immense Work.—Stand-pipe at Fair Haven, Mass. Ill. (F W-Nov. 4.) 500 w.

Serials.

16028. About Siphons. Ill. Leicester Allen (A M-Began Sept. 21—2 parts—15 cts. each).

16888. Supply Wells for Brooklyn (F W-Began Oct. 28—2 parts to date—15 cts. each).

17109. The Water Supply of London (Eng L-Began Oct. 27—1 part to date—30 cts).

INDUSTRIAL CHEMISTRY.

*16628. The Manufacture of Chlorates by Electrolysis. Bertram Blount (E P-Oct. 1.) 1100 w.

*16645. The Application of Electrolysis to Qualitative Analysis. Charles A. Kohn (El-Oct. 6.) 2000 w.

†17061. Certain Distinct Advances in the Analytical Chemistry of Recent Years. Albert B. Prescott (J A C S-July.) 1100 w.

†17062. On the Artificial Production of Petroleum. C. Engler (J A C S-July.) 1000 w.

INDUSTRIAL SOCIOLOGY.

*16472. The History of Strikes in America—II. Arthur A. Freeman (E M-Dec.) 3500 w.

†16480. The Drift of Land Reform. R. Munro Ferguson (C R-Oct.) 6000 w.

†16517. The Tyranny of Socialism. Review of book by Yves Guyot (W R-Oct.) 1000 w.

†16519. A Plea for the Farmer. W. F. G. (W R-Oct.) 2500 w.

†16522. "Setting the Poor on Work." James Mavor (N C-Oct.) 4500 w.

†16524. The Unemployed. Arnold White (F R-Oct.) 5000 w.

†16525. The Balance of Trade. George Chesney (F R-Oct.) 3500 w.

†16526. The Industrial Position of Women. Emilia F. S. Dilke (F R-Oct.) 4500 w.

16564. British Labor Statistics.—Reprint from N. Y. Sun (A A-Oct. 14.) 1000 w.

16586. The Tendency Toward Non-Unionism. Editorial. (A M & I W-Oct. 13.) 1000 w.

16665. Danger Signals. A. B. Salom (I I G-Oct.) 1100 w.

*16727. A Minister on the Right of Combination. James Wright (R R L-Oct. 13.) 1800 w.

†16789. Canadian Hostility to Annexation. J. Castell Hopkins (F-Nov.) 4800 w.

*16791. Immigration and the Sweating System. George E. Walsh (Ch-Nov.) 4500 w.

*16792. The Business Situation in the West. Albert Williams, Jr. (Ch-Nov.) 1800 w.

*16881. Choice of Occupation and Employer (I C B-Oct. 20.) 750 w.

16927. Business Ability. Editorial (M G-Oct. 28.) 1350 w.

*16929. Lord Kelvin on Government and Municipal Management of Public Undertakings. Editorial (E L-Oct. 20.) 500 w.

*16943. Sir James Kitson on Trade (I & S-Oct. 21.) 3000 w.

†16955. The Slave Power and the Money Power. C. W. Cram (A-Nov.) 4200 w.

16970. Profit Sharing. N. O. Nelson (A S-Oct. 28.) 1200 w.

†17024. The Productivity of the Individual. W. H. Mallock (N A R-Nov.) 4800 w.

†17026. Interest and Profits. Arthur T. Hadley (An A A-Nov.) 3800 w.

†17027. The Austrian Theory of Value. S. M. Macvane (An A A-Nov.) 10000 w.

†17028. The Subjective and the Objective View of Distribution. John Hobson (An A A-Nov.) 9500 w.

LANDSCAPE ENGINEERING.

16483. The Water Front of Public Parks (G & F-Oct. 11.) 1200 w.

16651. New York's Proposed Speed Road (G & F-Oct. 18.) 1400 w.

16652. The Water Garden at Clifton, N. J. Ill. J. N. Gerard (G & F-Oct. 18.) 1000 w.

MARINE ENGINEERING

16492. Blowing Up a Wreck (Sc A-Oct. 14.) 1300 w.

16493. The Yachts Contending for the International Championship. Ill. (Sc A-Oct. 14.) 500 w.

16503. Copper Coating the Hulls of Vessels By Means of Electricity. Ill. (Ir Age-Oct. 12.) 1000 w.

*16546. The "Lucania." Ill. (M E-Oct. 1.) 3000 w.

16587. Valkyrie-Vigilant. Editorial (M Rec-Oct. 12.) 900 w.

16681. The America's Cup Won by the Vigilant. Ill. (Sc A-Oct. 21.) 800 w.

16682. Floating Beacons and Luminous Buoys. Ill. (Sc A S-Oct. 21.) 4500 w.

*16688. The Modern Steamship.—The Construction of a Cunarder from Start to Finish. Ill. (M-Oct. 15.) 1700 w.

16710. Correction of Compass Courses for Change of Variation in the North Pacific. H. C. Pearsons (Sea-Oct. 19.) 1500 w.

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*17056. Statutory Authority. Editorial (E-Oct. 27.) 2000 w.

17064. Knoxville Shops of the East Tennessee, Virginia and Georgia Railway. Ill. (E N-Nov. 2.) 800 w.

*17079. The Working of Steam Pumps on the Russian South-Western Railways. Alexander Borodin (I C T-Oct. 27.) 3500 w.

*17110. Compound Locomotives. Editorial (Eng L-Oct. 27.) 1300 w.

17132. Relation of Surface Street Railroads to Steam Railroads. Editorial (E R-Nov. 4.) 600 w.

*17137. The Government of India and Private Railways (Tr-Oct. 27.) 600 w.

*17140. Train-Heating Trials on the Eastern Railway of France. F. Lancrenon (P Eng-Oct. 27.) 800 w.

17142. Air Brakes in Recent Accidents. Editorial (R M M-Nov.) 800 w.

17147. Railway Power Plants. Albert Blanchard (S R G-Nov. 4.) 900 w.

17149. The New Wickes Refrigerator Car (R R-Nov. 4.) 1900 w.

17150. Thoughts on Railroad Management. C. A. Hammond (R R-Nov. 4.) 2000 w.

17177. Electric Railway at Remscheld. Ill. J. Laffargue (W E-Nov. 11.) 750 w.

17190. Railroad Extension in India (R G-Nov. 10.) 1400 w.

17191. Cost of Locomotive Repairs. Editorial (R G-Nov. 10.) 1300 w.

17192. Noisy Locomotives. Editorial (R G-Nov. 10.) 750 w.

*17196. The Leicester Tramways. Ill. (R W-Oct.) 3300 w.

*17198. Proposed Underground Railway for Brussels. Ill. (R W-Oct.) 1400 w.

*17199. Heating and Cooking on Railways. Ill. (R W-Oct.) 1350 w.

*17200. The Working Expenses of Cable and Electric Tramways (R W-Oct.) 3000 w.

Serials.

7456. The Locomotive Boiler. Ill. Gustav Richard (A J R A-Began Oct., 1892—10 parts to date—30 cts. each).

9254. Railway Management. Horace Cope (R R-Began Dec. 31, 1892—8 parts to date—15 cts. each).

12001. Rails on the Creep. A. Ewbank (I E-Began March 11—26 parts to date—45 cts. each).

14226. Railway Rates and State Control (Tr-Began June 30—18 parts to date—30 cts. each).

15496. Railroad Copper-smithing. John Fuller, Sr. (L E-Began Sept.—3 parts to date—30 cts. each).

15824. The Development of South African Railways (E-Began Sept. 1—4 parts to date—30 cts. each).

16663. The Railroad Car at the World's Columbian Exposition. Ill. (R C J-Began Oct.—1 part to date—15 cts).

16664. The Strength of Some Materials Used

in Car Building (R C J-Began Oct.—1 part to date—15 cts).

16783. The Maintenance of the Overhead Line in Electric Street Railways. J. B. Cahoon (E W-Began Oct. 21—2 parts to date—15 cts. each).

16994. The Handling of Fuel on the French, English, and Belgian Railways. M. Jullian (A E R J-Began Nov.—1 part to date—30 cts).

17020. Construction and Inspection of Locomotive Boilers to Prevent Explosions. David L. Barnes (N C B-Began Nov.—1 part to date—30 cts).

17052. The Marseilles and St. Louis Elecric Road Railway. Ill. C. S. Du Riche Preller (E-Began Oct. 27—1 part to date—30 cts).

17197. Notes on American Railroads and Speeds. J. Pearson Pattinson (R W-Began Oct. —1 part to date—30 cts).

SANITARY ENGINEERING.

*16544. The New Rivers Pollution Prevention Bill (C T J-Oct. 7.) 1000 w.

*16611. The Sanitary Certification of Dwelling Houses. Edgar Flinn (Pl D-Oct. 2.) 1100 w.

†16786. Municipal Sanitation in New York and Brooklyn. J. S. Billings (F-Nov.) 3600 w.

*16951. The Bacteriological Boom and Hygienic Age (Inv.-Oct. 21.) 2500 w.

*16998. The Disposal of Sewage. S. A. Mitchell (J A E S-Sept.) 4200 w.

17021. Illuminating Gas.—Some of Its Injurious Products and How to Avoid Many of the Dangers Produced by These. John B. Coppock (Reprint from Herald of Health.) (A An-Nov. 1.) 1000 w.

17063. Sanitary Aspect of the Chicago Water Supply. Ill. (E N-Nov. 2.) 1200 w.

*17099. The Sanitary Planning of Hospitals. —Review of books by Douglas Galton (B A-Oct. 27.) 1600 w.

17134. Heating and Ventilating the Walbridge Office Building, Toledo, O. Ill. (E R-Nov. 4.) 1000 w.

17181. The Improved Sewage Disposal System of Milwaukee (E N-Nov. 9.) 1200 w.

Serials.

10425. A Healthy Home. Francis Vacher (S R-Began Feb. 1—18 parts to date—30 cts. each).

14966. The Treatment of Malarious Localities by the Sanitary Engineer (I E-Began July 8—4 parts to date—45 cts. each).

15062. The Utilization of Town Refuse for Power Production. Thomas Tomlinson (E R L-Began Aug. 4—8 parts to date—30 cts. each).

15132. A Review of Recent Plumbing Practice. G. Brown (N B-Began Aug.—2 parts to date—30 cts. each).

15438. Water Filtration and Cholera. R. Koch (San-Began Sept.—2 parts to date—45 cts. each).

16617. The Leading Principles of Scientific House Drainage and Sanitary Plumbing. William Paul Gerhard (Met W-Began Oct. 14—Ended Oct. 28—3 parts—15 cts. each).

STEAM ENGINEERING.

16547. The DeLaval Steam Turbine. Ill. (M & B-Sept.) 2400 w.

16569. Mechanical Boiler Cleaners. W. H. Wakeman (M G-Oct. 14.) 1400 w.

16590. Burning Dust Coal. P. F. Powers (B J C-Oct. 14.) 700 w.

16649. Trouble with a Boston Plant and How It was Remedied (M N-Oct. 15.) 850 w.

16654. Coal vs. Oil (T-Oct. 15.) 800 w.

16702. Smoke Prevention.—The Lesson Chicago Is Learning (B J C-Oct. 21.) 1000 w.

16703. Boiler Construction.—Existing Practice in English Shops (B J C-Oct. 21.) 2500 w.

*16733. Relative Values of Steaming Coals (M W-Oct. 13.) 1800 w.

16758. Setting the Cut-off on an Automatic Engine. W. H. Wakeman (A M-Oct. 19.) 500 w.

*16767. Piston Speeds (A J R A-Oct.) 800 w.

16806. The Hazelton or "Porcupine" Boiler. A. W. Wilkinson (A G L J-Oct. 23.) 3300 w.

16853. Forced Draft.—When It Is and Is Not Economical (B J C-Oct. 28.) 1000 w.

16918. The Willans Central-Valve Engine. Ill. (E M J-Oct. 28.) 3000 w.

*16948. Smoke Abatement (G W-Oct. 21.) 1650 w.

*16981. An Old Experiment with Balanced Valves (L E-Nov.) 1250 w.

*16982. Heating Surface of Firebox and of Tubes. Angus Sinclair (L E-Nov.) 2200 w.

16987. Babbitting Quarter Boxes. Ill. James F. Hobart (P S-Nov.) 1700 w.

17009. Something about Packing. W. H. Wakeman (A M-Nov. 2.) 1000 w.

*17044. Losses in Transmission of Heat. Ill. R. C. Carpenter (S J E-Oct.) 3000 w.

17074. The Heat Unit. William Norris (C E N-Nov.) 2500 w.

17143. Swedish Experiments with Boiler Fire-Boxes Lined with Fire-Brick. Ill. (R M M-Nov.) 700 w.

17165. Cost of Steam and Electrical Power (E W-Nov. 11.) 600 w.

Serials.

16408. Steam Plant in the New Netherland Hotel. Ill. (E R-Began Oct. 7—2 parts to date—15 cts. each).

16464. Burning Coal to Make Ice. W. H. Wakeman (M G-Began Oct. 7—Ended Oct. 28—3 parts—15 cts. each).

16655. The Steam Pump.—Information as to Its Classification and Characteristics (T-Began Oct. 15—2 parts to date—15 cts. each).

16666. On the Purification of Water Used for Steam Boilers (S V-Began Oct. 15—1 part to date—15 cts).

16756. Theory of Steam Engine Governors. J. Begtrup (A M–Began Oct. 19—1 part to date —15 cts).

17097. Variable Eccentrics. Ill. (M W–Began Oct. 27—1 part to date—30 cts).

TELEPHONY AND TELEGRAPHY.

16599. Long Distance Transmission. Louis Bell (W E–Oct. 14.) 1600 w.

16778. Recent Observations Concerning the Disturbing Influence of a Naked Buswire on Telephone Lines. C. Grawinkel (E R N Y–Oct. 21.) 500 w.

16829. A New Fibrous Insulation and Its Bearing on Underground Telegraph Lines. Charles Cuttriss (E W–Oct. 28) 1100 w.

16971. The Isle of Shoals Cable. Ill. (E N Y–Nov. 1.) 850 w.

*17058. The Telautograph. Editorial (E–Oct. 27.) 1100 w.

17075. Signals and Telegraphy. J. A. Douglas (C E N–Nov.) 1200 w.

17186. Field's New Magneto Telephone Transmitter-Receiver. Ill. (E E N Y–Nov. 8.) 450 w.

MISCELLANEOUS.

*16470. The Columbian Exposition from an European Standpoint J. Stephen Jeans (E M –Dec.) 4000 w.

*16471. Causes of Failure in "Boom" Towns. H. S. Fleming (E M–Dec.) 3000 w.

*16475. Relation of Chemistry to Engineering. Joseph Torrey (E M–Dec.) 2500 w.

*16476. American and Foreign Patent Systems. Casper L. Redfield (E M–Dec.) 3000 w.

16494. The World's Columbian Exposition: A General View. (Reprint from The Builder.) (Sc A S–Oct. 14.) 2800 w.

16504. Fuel Oil System at the Fair. Ill. (Ir Age–Oct. 12.) 2000 w.

†16515. Reviews of the Ice Age at the World's Congress on Geology (A G–Oct.) 2400 w.

†16527. Current Arguments for the Outlawry of Silver. Dana Horton (F R–Oct.) 3600 w.

†16528. The Rehabilitation of Silver. A. G. Schiff (F R–Oct.) 1000 w.

*16532. Theories of the Origin of Mountain Ranges.—Abstract of address by Prof. Le Conte (N–Oct. 5.) 4800 w.

*16538. Heating Engineer's Shops. Editorial (Eng L–Oct. 6.) 1400 w.

*16557. The Manchester Ship Canal.—Its Probable Effect on Liverpool, Manchester, and the Surrounding District (Tr–Oct. 6.) 2300 w.

16562. The Gazette des Beaux-Arts and the World's Fair (A A–Oct. 14.) 2500 w.

16570. New England's Industrial Prosperity. Reprint from the Wood-Worker (M G–Oct. 14.) 1400 w.

†16602. The International Electrical Congress and the World's Fair of 1893. Edwin J. Houston (T A I E E–Oct.) 10000 w.

16641. The Mechanics of Flight and "Aspiration." Ill. A. M. Wellington (E N–Oct. 12.) 5200 w.

16643. The Soaring Power of Birds. Editorial (E N–Oct. 12.) 2700 w.

*16696. Some Suggestions for a Good Patent Law. Editorial (E–Oct. 13.) 2500 w.

*16699. The Visit of the French Engineers to America. Editorial (E–Oct. 13.) 3000 w.

*16705. The Successor of the Chicago Exhibition. Reprint from N. Y. World. Edward Atkinson (A L–Oct. 13.) 1300 w.

16746. Gold as a Standard of Value. Oscar J. Frost (E M J–Oct. 21.) 4800 w.

†16785. America's Battle for Commercial Supremacy. John R. Proctor (F–Nov.) 3500 w.

*16794. The Picturesque Side of the World's Fair. Ill. F. Hopkinson Smith (Sc M–Nov.) 3500 w.

16808. The Toledo Blade's Silver Debate. Article by W. C. Wynkoop (M I T–Oct. 19.) 700 w.

16862. The Soaring Power of Birds. Editorial and Letters (E N–Oct. 28.) 3500 w.

†16871. Life in the Wilds of Central Africa. E. J. Glave (B G S–Sept. 30.) 8500 w.

†16872. The Polar Basin. Henry Seebohm (B G S–Sept. 30.) 3000 w.

*16879. Irish Forests (A L–Oct. 20.) 2800 w.

16887. Address of Commissioner Murphy at the Gloucester Convention of Firemen (F W–Oct. 28.) 4000 w.

16895. The Manufacture of Bottles (A M & I W–Oct. 27.) 1200 w.

16903. Inland Waterways and Transportation.—A Review of book by Emory R. Johnson (M Rec–Oct. 26.) 1800 w.

*16905. Mechanical Flight: the Sustention of the Weight. Horatio Phillips (E–Oct. 20.) 1200 w.

16979. Manual Training Schools.—Abstract of address by C. M. Woodward (C & B–Nov.) 1600 w.

*16988. Possibilities of the Great Northwest. S. A. Thompson (R of R–Nov.) 7500 w.

*16989. Inland Waterways for the Northwest. Emory R. Johnson (R of R–Nov.) 7500 w.

*16990. The Future of Silver Production. E. Benjamin Andrews (R of R–Nov.) 20000 w.

*16996. The Relation of the Engineer to Those with Whom He Comes in Professional Contact.—A Series of papers by D. Fitz Gerald, J. W. Ellis, W. E. McClintock, A. W. Locke, A. F. Noyes, M. M. Tidd, and Henry Manley (J A E S–Sept.) 6500 w.

*17043. Technical Education in the United States. R. H. Thurston (S J E–Oct.) 7000 w.

17065. The Compensation of Engineers. Editorial (E N–Nov. 2.) 2200 w.

*17087. A Californian Exhibition (I C B–Oct. 27.) 1600 w.

*17106. An Artist's Glimpse of Cairo. George Henry (A L–Oct. 27.) 3000 w.

*17111. The Education of Engineers. Editorial (Eng L–Oct. 27.) 2100 w.

*17116. The Finances of Engineering and the Engineering of Finance.—The House of Rothschild. Ill. (E Rev–Oct. 20.) 3200 w.

17162. Technical Education in Austria. Julius Goldschmidt (M N–Nov. 1.) 850 w.

17183. Has the Value of Gold Appreciated? Editorial (E N–Nov. 9.) 2200 w.

*17226. The World's Columbian Exposition. Editorial (E–Nov. 3.) 2000 w.

†17261. The Geographical Evolution of the North Sea. Ill. A. J. Jukes-Brown (C R–Nov.) 3200 w.

*17265. The Making of Mountain Chains. Ill. H. G. Wells (K–Nov. 1.) 2800 w.

†17308. An Attempt to Estimate the Thickness of the Ice-Blocks Which Gave Rise to Lakelets and Kettle-Holes. J. B. Woodworth (A G–Nov.) 1500 w.

†17309. Observations Along the Valley of Grand River, Mich. E. H. Mudge (A G–Nov.) 1500 w.

†17310. The Terms of Bioplastology. A. Hyatt (A G–Nov.) 4300 w.

†17311. Description of Some New Species of Crinoids, Blastoids and Brachiopods from the Devonian and Sub-Carboniferous Rocks of Missouri. Ill. R. R. Rowley (A G–Nov.) 2000 w.

†17312. The Pleistocene Rock Gorges of Northwestern Illinois. Oscar H. Hershey (A G–Nov.) 3000 w.

†17314. The Ice Age and Its Work. A. R. Wallace (F R–Nov.) 8500 w.

17378. How and Why Monarchy Was Overthrown in Hawaii (Sea–Nov. 16.) 2200 w.

17382. Ice Houses.—100 Years Ago (Sc A S–Nov. 18.) 1800 w.

Serials.

13998. Future of the Hot-Air Furnace. A. W. Glessner (Met W–Began July 1—19 parts to date—15 cts. each).

15433. British Colonies at Chicago (E–Began Aug. 18—Ended Oct. 20—7 parts—30 cts. each).

16290. The Atmosphere as a Medium of Travel. Fred W. Brearey (I & I–Began Sept. 15—4 parts to date—30 cts. each).

16434. The Flash-Point and Heat of Burning of Mineral Oils. D. R. Stewart (G W–Began Sept. 30—Ended Oct. 28—2 parts—30 cts. each).

16460. The Great Exhibition Reviewed. P. B. Wight (A A–Began Oct. 7—5 parts to date—15 cts. each).

16514. The Evolution of Artificial Light. Ill. E. L. Lomax (P A–Began Oct. 16—1 part to date—15 cts).

THE·TECHNICAL·INDEX

A CATALOGUE OF LEADING ARTICLES PUBLISHED CURRENTLY IN THE TECHNICAL JOURNAL OF THE UNITED STATES AND GREAT BRITAIN.

THIS publication has been aptly described as "the greatest step that has been taken in recent years towards systematizing work" for the engineer, the architect, the electrician, the railway manager, and the business man. The list of publications regularly indexed will show that it covers a world-wide range of the best technical literature, and all the articles are so conveniently classified under general headings that within a few minutes an active man can learn of everything that has been published during the month in relation to his special lines of investigation. In short, it is to the practical man just what Poole's celebrated index to periodicals has long been to the literary worker, but with this essential difference,—namely, that in addition to indicating *just where* leading articles have been published, *we undertake to supply copies of the articles themselves.* The unparalleled convenience and economy of this double service can readily be appreciated.

In ordering articles from us, care should be taken to give the *number*, not the title alone. The price of a single article is 15 cents, excepting those indicated by an asterisk (*), 30 cents, and by a dagger (†), 45 cents—according to the price of the publication quoted. All orders *must* be accompanied by cash or stamps.

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[In the body of the index only the initials of the journals quoted are given, and these can be readily identified by the following list of periodicals. Other abbreviations are: Ill=Illustrated. w=words.]

THE AMERICAN PRESS.

A .....Arena. *m.* $5 per year. Boston.
AA.....American Architect. *w.* $6. Boston.
Aer.....Aeronautics. *m.* $1. N. Y.
An A A..Annals of Am. Academy of Political and Social Science. *b-m.* $6. Philadelphia.
A An.... American Analyst. *f.* $1. New York.
A Ar.... American Artisan. *w.* $2. Chicago.
A & B....Architecture and Building. *w.* $6. N. Y.
A C J....Am. Chem. Journal. *b-m.* $4. Baltimore.
A E .....Architectural Era. *m.* $3. New York.
A E R J.Am. Eng. and Railroad Journal. *m.* $3. N.Y.
A G.....Am. Geologist. *m.* $3.50. Minneapolis.
A G L J..Am. Gas Light Journal. *w.* $3. New York.
A H.....Annals of Hygiene. *m.* $2. Phila.
A J Phar.Am. Journal of Pharmacy. *m.* $3. Phila.
A J R A..Jour. R'y. Appliances. *m.* $2. New York.
A M.....American Machinist. *w.* $3. New York.
A M & I W.Am. Man. and Iron World. $4. Pittsburg.
Am A.....American Agriculturist. *m.* $1.50. N.Y.
Am G....American Gardening. *m.* $1. New York.
Am S....American Shipbuilder. *w.* $2. New York.
A & N J..Army and Navy Journal. *w.* $6. New York.
A & N R..Army and Navy Register. *w.* $3. Wash'ton.
A R.....Architectural Record. *q.* $1. New York.
A Rev....Architectural Review. *s-q.* $5. Boston.
A S .....Age of Steel. *w.* $3. St. Louis.
B B.....Brick Builder. *m.* $2.50. Boston.
B C.....Boston Commonwealth. *w.* $2.50. Boston.
B & D...Builder and Dec. *m.* $2. Minneapolis.
B G S....Bul. Am. Geog. Soc. *q.* $5. New York.
B I S ...Bul. Am. Iron and St. Asso. *w.* $4. Phila.
B J C....Boston Jour. of Commerce. *w.* $3. Boston.
B & W...Builder and Woodworker. *m.* $1. N. Y.
C.....Compass. *m.* $1. New York.
C A.....Calif. Architect. *m.* $3. San Francisco.
Can A..Canadian Architect. *m.* $2. Toronto.
C & B...Carpentry and Building. *m.* $1. New York.
C E .....Colliery Engineer. *m.* $2. Scranton, Pa.
C E N...Canadian Elec. News. *m.* $1. Toronto.
C Eng....Canadian Engineer. *m.* $1. Montreal.
Ch.....Chautauquan. *m.* $2. Meadville, Pa.
C M.....Century Magazine. *m.* $4. New York.
Cos.....Cosmopolitan. *m.* $1.50. New York.
D E.....Domestic Engineering. *m.* $1. Chicago.
E A.....Electrical Age. *w.* $3. New York.
E E N Y..Electrical Engineer. *w.* $3. New York.
E I.....Electrical Industries. *m.* $3. Chicago.
E M.....Engineering Mechanics. *m.* $2. Phila.
E Mag ...Engineering Magazine. *m.* $3. New York.
E M J....Eng. and Mining Journal. *w.* $5. N.Y.
E N.....Engineering News. *w.* $5. New York.
Eng .....Engineer. *s-m.* $2. New York.
E N Y....Electricity. *w.* $2.50. New York.
E R.....Engineering Record. *w.* $5. New York.
E R N Y..Electrical Review. *w.* $3. New York.
E & R ...Elec. and Railroading. *m.* $1. Boston.
E S W P...Proc. Eng. So. of W.Pa. *m.* $7. Pittsburg.
E W.....Electrical World. *w.* $3. New York.
F .....Forum. *m.* $3. New York.
F D.....The Foundry. *m.* $1. Detroit.
F W.....Fire and Water. *w.* $3. New York.
G & F...Garden and Forest. *w.* $4. New York.
G G M...Goldthwaite's Geograp. Mag. *m.* $2. N. Y.
G R.....Good Roads. *m.* $2. New York.

THE TECHNICAL INDEX.

I A.....Inland Architect. *m.* $5. Chicago.
I Age....Inventive Age. *s-m.* $1. Washington.
Ir Age..Iron Age. *w.* $4.50. New York.
I I G.....Iron Ind. Gazette. *m.* $1.50. Buffalo.
I R W...India Rubber World. *m.* $3. New York.
I S F.....Industry. *m.* $2. San Francisco.
I T R....Iron Trade Review. *w.* $3. Cleveland.
J A .. ..Journal of Architecture. *m.* $2. Phila.
J A C S..Jour. Am. Chem. So. *m.* $5. Easton.
J A E S. Jour. Assoc. Eng. Soc. *m.* $3. Chicago.
J F I.....Jour. Franklin Institute. *m* $5. Phila
J M S I. .Jour. Milit. Service In. *b-m.* $4. NewYork.
J N E W..Jour.N.E Waterw. As. *q.* $2. New London.
J P E.....Jour. Polit. Economy. *q.* $3. Chicago.
J U S A..Jour. U. S. Artillery. *q.* $2.50. Ft. Monroe.
L E.....Locomotive Engineering. *m.* $2. N. Y.
L Mag...Lippincott's Magazine. *m.* $3. Phila.
M & B..Manufacturer and Builder. *m.* $1.50. N. Y.
M & El...Mech. and Electrician. *w.* $2. St. Louis.
Met W...Metal Worker. *w.* $2. N. Y.
M G.....Manufacturer's Gazette. *w.* $2.50. Boston.
Min.....Minerals. *m.* $1. N. Y.
Min. R...The Mining Review. *w.* $2. Denver.
M I T....Mining Industry. *w.* $2. Denver.
M N.....Mechanical News. *s-m.* $1.50. New York.
M R.....Manufacturer's Record. *w.* $4. Baltimore.
M R C...Marine Review. *w.* $2. Cleveland, O.
M Rec....The Marine Record. *w.* $2. Cleveland.
M S P....Min. and Sci. Press. *w.* $3. San Francisco.
M S R....Mining and Sci. Review. *w.* $2. Denver.
N A R...North American Review. *m.* $5. N. Y.
N B .....National Builder. *m.* $3. Chicago.
N C B...National Car Builder. *m.* $2. New York.
N P R...Nat. Popular Review. *m.* $2.50. Chicago.
N W.....Nowest. Architect. *m.* $3. Minneapolis.
O P D R..Oil, Paint and Drug Reporter. *w.* $6. N.Y.
P.....Paving. *m.* $2. Indianapolis.
P A.....Progressive Age. *s-m.* $3. New York.
P D.. ...Painting and Decorating. *m.* $1. Phila.
P E. .....Practical Electricity. *f.* $2. Boston.
P E C P.Proce. Engineer's Club. *q.* $2. Phila.
P S.....Power-Steam. *m.* $1. N. Y.
P S M....Popular Science Monthly. *m.* $5. N. Y.
R A.....Railway Age. *w.* $4. Chicago.
R C J...Railroad Car Journal. *m.* $1. New York.
R G .....Railroad Gazette. *w.* $4.20. N. Y.
R M.....Roller Mill. *m.* $2. Buffalo, N. Y.
R M M..Railway Master Mechanic. *m.* $1. Chicago.
R of R...Review of Reviews. *m.* $2.50. New York.
R R.....Railway Review. *w.* $4. Chicago.
R & T...Roofer and Tinner. *m.* $1. N. Y.
R'y N....Railway News. *m.* $2. New York.
S .. ..Stone. *m.* $2. Indianapolis, Ind
S A.....Southern Architect. *m.* $2. Atlanta.
San.....Sanitarian. *m.* $4. Brooklyn.
Sc.....Science. *w.* $3.50. New York
Sc A ....Scientific American. *w.* $3. New York.
Sc A S ...Scientific Am. Supplement. *w* $5. N. Y.
Sc M....Scribner's Magazine. *m.* $3. New York.
S E .....Stationary Engineer. *w.* $2. Chicago.
Sc Q ....Scientific Quarterly. *q.* $2. Golden, Cal.
Sea .....Seaboard. *w.* $2. New York.
S Ec ....Social Economist. *m.* $2. New York.
S J E....Sibley Jour. of Eng. *m.* $2. Ithaca, N. Y.
S M ....ScientificMachinist.*s-m.* $1.50. Cleveland, O.
So L .....Sou. Lumberman. *s-m.* $2. Nashville.
S M Q....School of Mines Quarterly. $2. N. Y.
S R E N..St. R'y. Elec. News. *m.* $2. Minneapolis.
S P.....Sanitary Plumber. *s-m.* $1. New York.
S R G ...Street Railway Gazette. *w.* $3. Chicago.
S R J ...Street Railway Journal. *m.* $4. New York.
S R N. ..Street Railway News. *w.* $3. New York.
S R R.. .Street Railway Review. *m.* $2. Chicago.
S S .....Southern States. *m.* $1.50. Baltimore.
S V.....Safety Valve. *m.* $1. New York.
T ... .Tradesman. *s-m.* $2. Chattanooga, Tenn.
T A I E E.Trans. Am. Ins. Elec. Eng. *m.* $5. N. Y.
T C E . Trans. Am. Soc. Civil Eng. *m.* $10. N. Y.
T Q.....Technology Quarterly. $3. Boston.
W E.. ..Western Electrician. *w.* $3. Chicago
W F E E.World's Fair Elec. Eng. *m.* $3. Chicago.
W G R..Water and Gas Review. *m.* $1. New York.

THE FOREIGN PRESS.

A L.....The Architect. *w.* 26*s.* London.
A M S.. Aust. Mining Standard. *w.* 30*s.* Sydney.
A P R...Aus. Pastoralists' Rev. *m.* 30*s.* Sydney.
B A... .The British Architect. *w.* 23*s.* 8*d.* London.
C G... .Colliery Guardian. *w.* 27*s.* 6*d.* London.
C R.....Contemporary Review. *m.* $4.50. London.
C T J....Chem. Trade Jour. *w.* 12*s.* 6*d.* Manchester.
D.....Discovery *w.* 8*s.* 8*d.* London.
E.....Engineering. *w.* 36*s.* London.
E E L....Electrical Engineer. *w.* 17*s.* 4*d.* London.
E G.....Engineers' Gazette. *m.* 4*s.* London.
E L.....Electricity. *w.* 6*s.* 6*d.* London.
El.. .....Electrician. *w.* 24*s.* London.
EngL... Engineer. *w.* 36*s.* London.
E P .....Electrical Plant. *m.* 6*s.* London.
E Rev....Engineering Review. *m.* 7*s.* London.
E R L....Electrical Review. *w.* 21*s.* 8*d.* London.
F R.....Fortnightly Review. *m.* $4.50. London.
G E M...Gas Engrs' Mag. *m.* 6*s.* 6*d.* Birmingham.
G W.....Gas World. *w.* 13*s.* London.
I .....Iron. *w.* 30*s.* London.
I & I....Industries and Iron. *w.* £1. London.
I & S....Iron and Steel Trades' Jour. *w.* 25*s.* London.
I C B... .Carpenter and Builder. *w.* 8*s.* 8*d.* London
I C T.... Iron and Coal Review.*w.* 30*s.* 4*d.* London.
I E .....Indian Engineering. *w.* 18 Rs. Calcutta.
Inv ..Invention. *w.* 28*s.* London.
J G L....Journal of Gas Lighting. *w.* London.
J S A... Journal of the So. of Arts. *w.* London.
K.....Knowledge. *m.* 6*s.* London.
M .....Machinery. *m.* 9*s.* London.
M E.....Marine Engineer. *m.* 7*s.* 6*d.* London.
M E & E J.Man. Eng. and Export Jour. *m.* London.
Min W..The Mining World. *w.* 21*s.* London.
M W.....Mechanical World. *w.* 8*s.* 8*d.* London.
N..... Nature. *w.* $7. London.
N C.....Nineteenth Century. *m.* $4.50 London.
P Eng...Practical Engineer. *w.* 10*s.* London.
Pl D .....Plumber and Decor. *m.* 6*s.* 6*d.* London.
R N.....Railway News. London.
R P L....The Railway Press. *m.* 7*s.* London.
R R L...The Railway Review. *w.* London.
R W.....Railway World. *m.* $5. London
S L.....Steamship. *m.* Leith, Scotland.
S R.....Sanitary Record. *m.* 10*s.* London.
Tr.....Transport. *w.* £1. 5*s.* London.
W R...:.Westminster Review. *m.* $4.50. London.

ARCHITECTURE.

*17213. The Architectural Event of Our Times. Ill. Henry Van Brunt (E Mag-Jan.) 4000 w.

17215. The Purpose of Architectural Exhibitions. Editorial (A & B-Nov. 11.) 700 w.

*17239. Roof Trusses. Ill. (N B-Nov.) 600 w.

*17240. The Treatment of Ceilings (B & D-Oct.) 1100 w.

*17241. Color and the American Country House. Edward Hurst Brown (B & D-Oct.) 1300 w.

*17245. The Restoration of Dunblane Cathedral (B A-Nov. 3.) 2200 w.

*17246. Mr. William Morris on Westminster Abbey (B A-Nov. 3.) 900 w.

17268. Introduction of Building Specialties—Reprint from Building News (A A-Nov. 11.) 1800 w.

*17272. Birds in Decoration. The Stork. Ill. H. Leslie Ramsey (Pl D-Nov. 1.) 1000 w.

*17273. Symbolism in Art (A L-Nov. 3.) 2500 w.

*17274. Carving in Paris. Extracts from papers by P. G. Hamerton (A L-Nov. 3.) 1100 w.

*17275. Stirling as It Was. Dr. Galbraith (A L-Nov. 3.) 1700 w.

17413. Limitations of the Greek Style (A & B-Nov. 18.) 700 w.

17414. Foundations of the New Stock Exchange Building, Chicago. Ill. From the Inter-Ocean (A & B-Nov. 18.) 1500 w.

*17475. Architectural Examination and Registration (B A-Nov. 10.) 1100 w.

*17492. Spanish Renaissance. Review of book by Andrew N. Prentice (A L-Nov. 10.) 4800 w.

*17493. The State and Art (A L-Nov. 10.) 2700 w.

*17507. American School Buildings. Walter S. Pardee (Can A-Nov.) 3000 w.

*17556. From Vienna to Varna. Ill. John H. Vincent (Ch-Dec.) 2000 w.

17564. The Eccentric Loading of Cast Iron Columns. Ill. John C. Trautwine (E N-Nov. 23) 900 w.

*17646. How to Study Design. A. B. Pite (A L-Nov. 17.) 5300 w.

17721. Wood Cement Roof. Ill. (C & B-Dec.) 800 w.

17763. Influence of the Royal Institute Examinations. (Extract.) E. W. Mountford (A & B-Dec. 2.) 1800 w.

*17789. Granite in Building and Construction. John Glenville Murphy (S-Sept.) 6100 w.

*17794. Factory Construction. Ill. Slide-Rule (S-Oct.) 1000 w.

*17795. Rubble Masonry. Ill. I. C. U. (S-Oct.) 1500 w.

*17796. The Marbles of Belgium. Arthur Lee (S-Oct.) 1100 w.

*17802. Crushed Steel for Stone Sawing. Ill. (S-Nov.) 600 w.

17816. Shingling a House. James F. Hobart (T-Dec. 1.) 5000 w.

*17855. Thoughts on Architectural Composition (A L-Nov. 24.) 2000 w.

*17856. Geometrical and Flowing Tracery (A L-Nov. 24.) 2100 w.

17940. Pneumatic Foundations for the Manhattan Life Building, New York. Ill. (E N-Dec. 7.) 900 w.

17966. Precedent the Keystone of Architectural Development. George C. Mason, Jr.—Reprint from Philadelphia Times (A & B-Dec. 9) 800 w.

Serials.

10682. The Chateaux of France. Ill. Louis H. Gibson (S-Began Feb.—8 parts to date—30 cts. each).

12415. Typographical and Architectural History of the City of Mexico. Ill. Arthur Howard Noll (A A-Began April 29—3 parts to date—15 cts. each).

12568. Building Construction and Superintendence. Ill. F. E. Kidder (A & B-Began May 6—15 parts to date—15 cts. each).

13358. Modern Asylums for the Insane. George H. Bibby and Ernest A. E. Woodrow (A A-Began June 3—8 parts to date—15 cts. each).

17100. Town Halls. Ill. E. Rümler (A A-Began Nov. 4—Enced Nov. 18—3 parts—15 cts. each).

17476. Presidential Address of J. MacVicar Anderson (B A-Began Nov. 10—Ended Nov. 24—2 parts—30 cts. each).

17572. Museums. Ill. E. Rümler (A A-Began Nov. 25—Ended Dec. 2—2 parts—15 cts. each).

17782. Stones of Other Countries. George P. Merrill (S-Began Aug.—3 parts to date—30 cts. each).

17785. Building Stones in Missouri. Ill. Arthur Winslow (S-Began Sept.—3 parts to date—30 cts. each).

17790. Vermont Marble Deposits. Ill. George C. Underhill (S-Began Sept.—3 parts to date—30 cts. each).

CIVIL ENGINEERING.

*17210. An Era of Mechanical Triumphs. Ill. Prof. Robert H. Thurston (E Mag-Jan.) 3500 w.

*17219. The Design of Retaining Walls (J G L-Oct. 31.) 2200 w.

*17284. Evolution of the Horizontal Girder. Editorial (Eng L-Nov. 3.) 2200 w.

*17285. The Corinth Canal Works. Ill. (Eng L-Nov. 3.) 700 w.

17366. Concrete Iron Roadway Bridge at Neuhausel, Hungary. Ill. (E N-Nov. 16.) 800 w.

17380. Roads of Italy and Spain. Reprint from N. Y. Sun (Sc A S-Nov. 18.) 1650 w.

17381. New Ferry Bridge and Other Engineering Works at Bilbao, Spain. Ill. (Sc A S-Nov. 18.) 1000 w.

†17402. The Continuous Superstructure of the Memphis Bridge. Ill. George S. Morison (T C E-Sept.) 18000 w.

†17403. Bridge Superstructure and Foundations in Nova Scotia. Ill. Martin Murphy (T C E-Sept.) 7000 w.

†17404. Improved Method of Constructing Foundations Under Water by Forcing Cement into Loose Sand or Gravel by Means of Air Pressure. Ill. Fr. Neukirch (T C E-Sept.) 1300 w.

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17417. Furnace Slag for Paving. Editorial. (M R-Nov. 17.) 450 w.

17505. The Testing of Portland Cement. Pierre Giron (E M J-Nov. 18.) 2000 w.

17560. Present Condition of the Brazos River Harbor Works (E N-Nov. 23.) 900 w.

17562. Construction of Pivot Pier, Interstate Bridge, Omaha, Neb. Ill. (E N-Nov. 23.) 1500 w.

†17592. The Burning of Portland Cement.—Description of the Various Systems in Use, with Discussion. Ill. Pierre Giron (P E C P-July.) 1800 w.

17649. The Value of Tensile Tests of Neat Cement. Editorial (E R-Nov. 25.) 700 w.

17651. Erection of French Viaducts. Ill. (E R-Nov. 25.) 500 w.

17652. Removal of a Defective Pivot Pier and Its Reconstruction. Howard G. Kelley (E R-Nov. 25.) 1100 w.

*17655. Profit and Loss to the Farmer.—Good Roads an Investment. Ill. N. G. Spalding (G R-Nov.) 1600 w.

*17748. How France Got Good Roads. Arthur Lagron (P-Dec.) 1700 w.

*17779. The Public Road of New England. G. H. Harris (S-Aug.) 1350 w.

*17801. Stone Road Construction. (Extract.) Julius H. Striedinger and Otto von Geldern (S-Nov.) 2500 w.

*17803. Crushed Steel on Rubbing Beds. Ill. (S-Nov.) 850 w.

17830. The English Channel Bridge (R G-Dec. 1.) 1000 w.

*17837. Another Great Mountain Tunnel.—The Story of the St. Gothard (Tr-Nov. 24.) 1800 w.

17883. A Great Memorial Bridge. Ill. Alonzo C. Mather (I Age-Dec.) 1700 w.

*17890. Modern Street Pavements. Ill. O. B. Gunn (J A E S-Oct.) 8500 w.

17919. The Jetty Works at the Mouth of the Mississippi River. E. L. Corthell (Sc A S-Dec. 9.) 800 w.

17934. The 520-ft. Swing Span, Interstate Bridge, Omaha, Neb. Ill. (E N-Dec. 7.) 700 w.

17941. Standard Expansion Bearings for Bridges. Ill. (Abstract.) George S. Morison (E N-Dec. 7.) 1300 w.

Serials.

8671. MacAdam and Telford Roads. Ill. Isaac B. Potter (G R-Began Nov. 1892—6 parts to date—30 cts. each).

13194. Highway Bridges. Ill. John N. Ostrom (G R-Began May—7 parts to date—30 cts. each).

16520. Plant and Gear Made Locally for the Kistna Bridge. Ill. (I E-Began Sept. 9—3 parts to date—45 cts. each).

16677. Road Work at Flushing. Ill. (G R-Began Oct.—Ended Nov.—2 parts—30 cts. each.

ELECTRICAL MISCELLANY.

*17214. Electricity in 1876 and 1883. Ill. Elihu Thompson (E Mag-Jan.) 5000 w.

*17242. Kelvinside Electricity Supply. Ill. (I & I-Nov. 3.) 5200 w.

*17243. Electric and Magnetic Elasticity. Editorial (I & I-Nov. 3.) 1000 w.

*17258. Compensation for Hysteresis. Ill. E. B. Vignoles (El-Nov. 3.) 800 w.

*17259. The Pollak System of Charging Secondary Batteries from Alternators. Ill. (El-Nov. 3.) 1700 w.

*17302. The Action of Continuous and Alternating Currents in Alloys for Fuse Wire. Ill. (E R L-Nov. 3.) 1400 w.

17326. Accumulators and Their Uses (P A-Nov. 15.) 700 w.

17338. Triphase Current Electrical Transmission at Redlands, California. Ill. (E E N Y-Nov. 15.) 1000 w.

17356. The Bismuth Magnetic Field Explorer. Dr. Th. Bruger (E W-Nov. 18.) 600 w.

17357. A Storage Battery for Central Station Service. Ill. (Sc A-Nov. 18.) 800 w.

17383. Measurement of the Electric Power of Alternating Currents—Zipernowsky's Wattmeter. Ill. (Sc A S-Nov. 18.) 1200 w.

17384. Electricity in Insurance Matters (W E-Nov. 18.) 3300 w.

*17390. Electrical Terms—Reprint from Boston Transcript (S A-Nov.) 1000 w.

†17407. Carbon and Its Uses in Electrical Engineering. Clarence M. Barber (T C E-Sept.) 3000 w.

*17438. The Electrical Resistance of Metals and Alloys at Very Low Temperatures. Editorial (E R L-Nov. 10) 1200 w.

*17439. Chloride of Lead Secondary Batteries. Emile Andreoli (E R L-Nov. 10.) 550 w.

*17440. Alternators in Series and Parallel. Ill. Arthur Whitwell (E R L-Nov. 10.) 1000 w.

*17465. Permeability and Inductive Capacity. Editorial (I & I-Nov. 10.) 1200 w.

*17471. The Electrical Concentration of Vitriol. Bertram Blount (El-Nov. 10.) 1100 w.

17477. Improvements in the Storage of Electricity. F. H. Bowman (Sc-Nov. 10.) 2800 w.

*17485. A Sermon on Switchboards. James Raley (S R R–Nov.)–900 w.

17515. Electricity on the Erie Canal (E R N Y–Nov. 25.) 600 w.

17516. Electrical Apparatus on "El Cid" (E R N Y–Nov. 25.) 600 w.

17518. Some Recent Developments in Alternating Current Motors. Ill. Elias E. Ries and Gordon J. Scott (E R N Y–Nov. 25.) 1800 w.

17527. Electrical Canal Boat Propulsion on the Erie Canal, with Editorial. Ill. (E E N Y–Nov. 22.) 2200 w.

17535. New Fire Alarms. Ill. (Sc A–Nov. 25.) 1200 w.

17538. Electrical Action of Light upon Silver. J. Waterhouse (Sc A S–Nov. 25.) 2800 w.

*17599. Nodal Systems of Electric Waves Obtained by Lecher's Method. Ill. Domenico Mazzotto (El–Nov. 17.) 900 w.

*17601. American Electrical Engineering and Its Lessons. Editorial (El–Nov. 17.) 1500 w.

*17609. Niagara Falls Electricity Works. Editorial (E R L–Nov. 17.) 2000 w.

*17614. Electrical Progress Demonstrated at the Late Chicago Exhibition. Editorial (Inv–Nov. 18.) 900 w.

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17675. A Second Test of Electric Power on the Erie Canal (E R N Y–Nov. 29.) 1000 w.

17690. Electric Motors for Canal Boat Propulsion. Editorial (E N–Nov. 30.) 1700 w.

17706. A Sculptor's Electric Motor. Ill. (W E–Dec. 2.) 800 w.

†17730. Load Factors in Station Economics; With Their Bearing on Water Power Plants. John Mackenzie (S R J–Dec.) 3300 w.

*17752. Central Stations and New Transformers. Ill. G. Claude (El–Nov. 24.) 1500 w.

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*17812. The Distribution of Power from Niagara. Editorial (E–Nov. 24.) 2900 w.

*17851. Fitz Gerald's Improved Lithanode and Spongy-Lead Plates (E E L–Nov. 24.) 1000 w.

*17852. On the Evolution of Gas During the Changing of Accumulators. C. Bruegemann (E E L–Nov. 24.) 500 w.

*17866. The Beaumont Variable Power-Gear Applied to Electric Locomotives. Ill. E. C. De Segundo (I & I–Nov. 24.) 1500 w.

17884. Electricity in the United States Weather Bureau Exhibit at the World's Fair. C. W. Swoope (E N Y–Dec. 6.) 1200 w.

17887. New York Electrical Society.—An Interesting Meeting. Addresses by C. O. Mailloux, Nikola Tesla, F. B. Crocker, C. E. Emery, J. J. Carty, James Hamblett and others. (E R N Y–Dec. 6.) 8500 w.

17909. Mechanical Engineering the Basis for the Electrical Engineer (Ir' Age–Dec. 7.) 700 w.

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17945. Electricity on a French Canal. Ill. (W E–Dec. 9.) 550 w.

†17946. The Fire Hazards of Electricity. William Brophy (T Q–July) 3300 w.

†17947. Fire Risks and Electric Wires. H. F. Parshall (T Q–July) 1800 w.

17965. Type-Setting by Electricity (B J C–Dec. 9.) 650 w.

Serials.

9771. What is Electricity? Sydney F. Walker (E E L–Began Jan. 6—5 parts to date—30 cts. each).

9858. The Calculations of Alternating Current Motors. Ill. E. Arnold (E W–Jan. 21—4 parts to date—15 cts. each).

10464. The Silver Plating Industry. Ill. (I & I–Began Feb. 3—6 parts to date—30 cts. each).

11501. Theory of the Transformer. F. Bedell and A. C. Crehore (E W–Began March 25—8 parts to date—15 cts. each).

11560. Electric Motive Power. Albion T. Snell (El–Began March 17—12 parts to date—30 cts. each).

16096. Commercial Magnetism. J. S. (I & I–Began Sept. 15—7 parts to date—30 cts. each).

16228. Electric Supply Companies. Ill. (E E L–Began Sept. 22—5 parts to date—30 cts. each).

16740. Primary Batteries in Theory and Practice. Ill. W. R. Cooper (El–Began Oct. 30—Ended Nov. 3—4 parts—30 cts. each).

17131. The New System of Alternating Current and Transformer Distribution. Rankin Kennedy (E R L–Began Oct. 27—3 parts to date—30 cts. each).

17156. Transformer Diagrams Experimentally Determined. Ill. Frederick Bedell—assisted by A. W. Berresford, W. M. Craft, and B. Gherardi, Jr. (E N Y–Began Nov. 8—Ended Nov. 22—3 parts—15 cts. each).

17348. The Primary Action of the Galvanic Current. J. Mount Bleyer and M. Milton Weill (E R N Y–Began Nov. 18—Ended Nov. 29—3 parts—15 cts. each).

17354. How Galvanometer Coils Should Be Wound. Edwin F. Northrup (E W–Began Nov. 18—2 parts to date—15 cts. each).

We supply copies of these articles. See introductory.

17355. Relation Between Increase of the Dimensions and Rise of Output of Dynamos. Alfred E. Wiener (E W–Began Nov. 18—2 parts to date—15 cts. each).

17546. Recollections of Werner von Siemens (E N Y–Began Nov. 22—3 parts to date—15 cts. each).

17568. Domestic Electrical Work. Ill. W. A. W (Met W–Began Nov. 25—3 parts to date—15 cts. each).

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17745. The Storage Battery Question (M G–Began Dec. 2—1 part to date—15 cts).

17880. A Simplified Method of Calculating Dynamo Output and Proportions. Cecil P. Poole (E E N Y–Began Dec. 6—1 part to date—15 cts).

ELECTRIC LIGHTING.

*17232. Potential Readings of Arc Lamps. Ill. Carl K. Mac Fadden (E I–Nov.) 1000 w.

*17303. A Double Filament Incandescent Lamp. Ill. (E R L–Nov. 3.) 250 w.

17339. Economy in Small Central Station Lighting.—Transformers in a Three Wire System. Ill. (E E N Y–Nov. 15.) 500 w.

17340. Arc Lamp Design. W. A. Turbayne (E E N Y–Nov. 15.) 1300 w.

17341. The Increase in Municipal Electric Lighting Plants. Editorial (E E N Y–Nov. 15.) 750 w.

17393. Electric Lighting Points for the Dynamo Tenders, the Engineer, and the Owner of the Plant (T–Nov. 15.) 3600 w.

†17408. The Guadalajara Electric-Light Installation, Utilizing the Famous Juanacatlán Water-Falls, 28 Km. Distance from Guadalajara. Ill. Rafael M. de Arozarena (T E C–Sept.) 2000 w.

*17472. The Glow-Lamp Monopoly. Editorial (El–Nov. 10.) 1800 w.

*17474. Bowden's Patent Cable Coupling. Ill. (El–Nov. 10.) 500 w.

*17497. The Gas Engine and Electric Lighting. George A. Farwell (I C B–Nov. 10.) 1600 w.

*17503. Honor to Whom Honor Is Due. Editorial (E E L–Nov. 10.) 1300 w.

17513. An Electric Tower of Light.—The Most Prominent Feature of the California Midwinter Exposition. Ill. (E R N Y–Nov. 25.) 500 w.

17520. Candle Power of Search Lights. Ill. Charles P. Steinmetz (E W–Nov. 25.) 1400 w.

17526. Feeder Regulation Without Resistance. Ill. W. S. Barstow and C. O. Mailloux (E E N Y–Nov. 12.) 2000 w.

17528. Automatic Switches for Controlling Distant Lamps. Ill. (E E N Y–Nov. 22.) 650 w.

*17598. Photometric Fantasies (El–Nov. 17.) 1000 w.

17636. Electric Lighting for Mills. Alfred A. Hunting (M G–Nov. 25.) 3000 w.

17663. English Wiring and Insulation Tests. J. Appleton (E E N Y–Nov. 29.)1200 w.

*17765. Electric Light Mains. Editorial (E R L–Nov. 24)) 1350 w.

*17768. The Electric Lighting of the Town of Brussels (E R L–Nov. 24.) 2000 w.

*17869. The Incandescence Lamp Situation. Editorial (I & I–Nov. 24.) 800 w.

17878. Fire Proof Power Stations. J. H. Vail (S R G–Dec. 2.) 700 w.

17882. Flexible Canal Boat Trolley. Jno. Dennis, Jr. (E E N Y–Dec. 6.) 600 w.

17897. Steamboat Lighting by Electricity. R. W. Herring (C E N–Dec.) 1800 w.

17904 The Economical Installation of Small Lighting Plants. J. B. Cahoon (E W–Dec. 9.) 900 w.

Serials.

13548. Arc Lighting. Ill. E. Tremlett Carter (E R L–Began June 2—12 parts to date—30 cts. each).

16399 Electric Light, Thermal Storage, and Utilization of Town Refuse. C. C. Keep (I & I–Began Sept. 29—Ended Nov. 3—4 parts—30 cts. each).

16631. The Scientific Study of Arc Lamps. Ill. Rankin Kennedy (E R L–Began Oct. 6—3 parts to date—30 cts. each).

GAS ENGINEERING.

*17220. High vs. Low Temperature in the Cracking Up of Oils. R S Moss (J G L–Oct. 31.) 3000 w.

*17277. Gas Engines for Central Electric Lighting Stations. Editorial (E P–Nov. 1.) 1500 w.

*17297. Residuals. Ideas Concerning Them Suggested by the Outlook. James Ferrier (G W–Nov. 4.) 1200 w.

17327. Carbureting Illuminating Gas. H. Bunte (P A–Nov. 15.) 4000 w.

17363. Gas Engines. W. H. Booth (A M–Nov. 16.) 1300 w.

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*17581. The Chemist in Gas Works (G E M–Nov. 10.) 1000 w.

*17702. Gas Undertakings and the Price of Coal. Norton H. Humphreys (J G L–Nov. 21.) 1800 w.

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17737. Artificial Illumination. William Paul Gerhard (A A–Dec. 2.) 2300 w.

*17821. Fly Wheels for Gas Engines. Ill. Charles Day (P Eng–Nov. 24.) 900 w.

*17854. Oxy-Oil Gas (Tatham's Process) and Its Use for Purposes of Enrichment, with Discussion. L. T. Thorne (G W–Nov. 25.) 14900 w.

17865. Gas in the Kitchen. Herman Poole (A G L J–Dec. 4.) 2000 w.

Serials.

17754. Tests of Gas Burners (El-Began Nov. 24—1 part to date—30 cts).

HYDRAULICS.

17231. The Prospect Park Water Tower, Brooklyn, N. Y. Ill. (E R-Nov. 11.) 1000 w.

*17270. Water: Demand, Supply and Dangers. Editorial (Pl D-Nov. 1) 800 w.

*17287. Waste Sluices. Ill. (Eng L-Nov. 3.) 1800 w.

17296. The Geology of Wisconsin Water Supplies. Daniel W. Mead (F W-Nov. 11.) 3800 w.

17394. Water Power Possibility—How Electricity Can Be Developed from the Streams in East Tennessee (T-Nov. 15.) 1500 w.

*17496. The Divining Rod (I C B-Nov. 10.) 1200 w.

17630. The Liability of Water Supply Companies. D. Ostrander (F W-Nov. 25.) 2000 w.

17631. Incidents in Water Supply Tests. J. T. Fanning (F W-Nov. 25.) 2800 w.

*17813. Hydraulic Machinery. Editorial (E-Nov. 24.) 1400 w.

*17814. Impounding Reservoirs in India and Masonry Dams. Abstracts of papers by W. J. B. Clerke, Jagannath Sadasewjee, S. S. Jacob, and Franz Kreuter (E-Nov. 24.) 2500 w.

17853. High Earthen Dams for Storage Reservoirs. L. J. Le Conte (F W-Dec 2.) 1700 w.

†17923. Natural Filtration for Domestic Water Supply, with Discussion. G. Kaufman (E S W P-Oct.) 7800 w.

17925. Hydraulic Ejectors. Ill. E. A. Wiltsee (M S P-Dec. 2) 1000 w.

17937. The Neckar River Water Filtration Plant of Stuttgart, Germany. Ill. William P. Mason (E N-Dec. 7.) 650 w.

†17949. The Hydraulic Laboratory of the Massachusetts Institute of Technology. Ill. Dwight Porter (T Q-July.) 1400 w.

Serials.

17109. The Water Supply of London (Eng L-Began Oct. 27—3 parts to date—30 cts. each).

INDUSTRIAL CHEMISTRY.

†17306. On the Occlusion of Gases by the Oxides of Metals. Theodore William Richards and Elliot Folger Rogers (A C J-Nov.) 3500 w.

†17307. The Effect of Platinum on Iron Solutions. R. W. Mahon (A C J-Nov.) 1700 w.

17318. Chemistry in the Foundry. W. J. Keep (F D-Nov. 10.) 800 w.

*17557. Chemistry at the World's Fair. Marcus Benjamin (Ch-Dec.) 3000 w.

†17846. The Chemical Industry of the United States. Henry Bower (J A C S-Oct.) 1800 w.

Serials.

17576. Theoretical and Practical Ammonia Refrigeration. Iltyd J. Redwood (Eng-Began Nov. 25—2 parts to date—15 cts. each).

INDUSTRIAL SOCIOLOGY.

17229. The Labor Question in Holland (E R-Nov. 11.) 1600 w.

†17260. The English Poor Law and Old Age. J. Frome Wilkinson (C R-Nov.) 4800 w.

†17262. The Miners' Battle—and After. Sydney Olivier (C R-Nov.) 8000 w.

*17263. Trades Unionism—An Eloquent Eulogy by the Rev. Stopford Brooke (R R L-Nov. 3.) 3000 w.

†17315. Is Money a Mere Commodity? William Smart (F R-Nov.) 3500 w.

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17468. Bridges and Buildings.—Seventh Paper in Competition for the Railway Age Prize (R A—Nov. 17.) 750 w.

*17480. Street Cars in South Africa. Ill. (S R R—Nov.) 550 w.

*17481. The Scranton and Carbondale Electric Railway. Ill. (S R R—Nov.) 1000 w.

*17482. Rail Joints. Ill. (S R R—Nov.) 500 w.

*17484. An Electric Car Elevator. Ill. (S R R—Nov.) 450 w.

*17486. Making a Street Car in Spain. Ill. (S R R—Nov.) 1000 w.

*17487. Mobile's New Rapid Transit. Ill. (S R R—Nov.) 700 w.

*17489. Fog-Signalling.—Invention of T. H. Skinner (R R L—Nov. 10.) 1500 w.

*17498. The Development of the Electric Locomotive. Ill. (P Eng—Nov. 10.) 2400 w.

17517. Shall Elevated Roads Adopt Electricity? Editorial (E R N Y—Nov. 25.) 900 w.

17522. More Data on Traction Experiments. Elmer A. Sperry (E W—Nov. 25.) 500 w.

17533. Rail Joints in General—Welded Ones in Particular. Joseph Torrey (A M—Nov. 23.) 2500 w.

*17541. Signals and Safety. Editorial (A J R A—Nov.) 800 w.

*17543. The Locomotive Fire-Box (A J R A—Nov.) 2000 w.

*17545. The Inertia of Trains and the Reciprocating Parts of Machinery (A J R A—Nov.) 800 w.

*17565. Profiles of Notable Abt Rack Railways, with Details of Operation and Construction. Ill. (E N—Nov. 23.) 2200 w.

17567. Normal Danger or Normal Clear? Editorial (R G—Nov. 24.) 1200 w.

17582. A Four-Track Suburban Train Ser-

vice.—Illinois Central Railroad (R A–Nov. 24. 1200 w.

*17583. Minor Improvements in Locomotives (M W–Nov. 17.) 1250 w.

*17616. Some Curious and Noteworthy Railways.—Reprint from the Evening Standard (Inv–Nov. 18.) 1100 w.

*17627. The Railway Year in Victoria (Tr–Nov. 17.) 2500 w.

17650. Car Fenders for Street Railways. Editorial (E R–Nov. 25) 850 w.

17660. The Hausshalter Speed Recorder. Ill. (R R–Nov. 25.) 1350 w.

17661. Relative Use and Importance of Railways and Waterways. A. V. Gude (R R–Nov. 25.) 1800 w.

17665. The Strain on Electric Railway Poles. R. C. Hull (E E N Y–Nov. 29.) 450 w.

17666. Trolley Accidents. L. Gutmann (E E N Y–Nov. 29.) 1900 w.

17667. Trolley Accidents, Their Causes and Means of Prevention. J. E. Lockwood (E E N Y–Nov. 29.) 1800 w.

17669. The Field Railway Case (E E N Y–Nov. 29.) 4200 w.

17674. The Motorman. Julian A. Moses (E R N Y–Nov. 29.) 2000 w.

*17698. Steel Freight Cars. Ill. (N C B–Dec.) 1200 w.

†17725. The Eastern Power Station of the Brooklyn City Railroad. Ill. (S R J–Dec.) 2000 w.

†17726. A Expensive Piece of Track Construction.—Heights of North Hudson. Ill. (S R J–Dec.) 600 w.

†17727. A Different Piece of Engineering.—Steinway Railway Company. Ill. (S R J–Dec.) 600 w.

†17728. Storage Battery Cars in New York. Ill. (S R J–Dec.) 2400 w.

†17729. Early Types of Fenders. Ill. (S R J–Dec.) 1300 w.

*17760 William Baxter's Compound Locomotive, Built in 1870. Ill. John H. Cooper (L E–Dec.) 1000 w.

*17761. Train Running for the Confederacy. Carter S. Anderson (L E–Dec.) 2000 w.

17770. Best Method of Elevating Track for Curves on Bridges. Ill. (R A–Dec. 1.) 1800 w.

†17807. Railroad Accidents in the United States and England. H. G. Prout (N A R–Dec.) 3000 w.

17831. Moving Track on the New York, New Haven and Hartford. Ill. (R G–Dec. 1.) 1200 w.

17832. Passaic Draw-bridge—New York, Lake Erie and Western Railroad. Ill. (R G–Dec. 1.) 400 w.

17833. Wheel Flanges and Guard Rail Clearances. Ill. George Tatnall (R G–Dec. 1.) 2500 w.

17835. The Judge's Opinion in the Air-Brake Suit. Editorial (R G–Dec. 1.) 3000 w.

17836. Opinion of Judge Townsend Sustaining the Broad Claims of the Westinghouse Quick-Action Air-Brake Patents (R G–Dec. 1.) 16000 w.

*17838. "Trains of Luxury" (Tr–Nov. 24.) 1500 w.

*17844. The Soulerin Continuous Railway Brakes. Ill. L. S. (E Rev–Nov. 20.) 3700 w.

*17872. Metallic Ties on the Grand Central Railway of Belgium. Ill. (A E R J–Dec.) 1900 w.

17374. Two Notable Railway Trains. Ill. (R R–Dec. 2.) 1800 w.

17879. Gas Motor Cars Used in Dresden. Ill. (S R G–Dec. 2.) 700 w.

17886. The Power House Man. Julian A. Moses (E R N Y–Dec. 6.) 1700 w.

17902. Railroad Construction in Old and Modern Times. Ill. (Sc A–Dec. 9.) 1800 w.

17907. Electric Heating for Street Cars. Edward B. Wyman (E W–Dec. 9.) 600 w.

*17922. Railway to Central and South America (I S F–Dec.) 600 w.

17927. Block System on Single Track Railroads, with the Interlocking Staff System. Ill. T. H. Patenall (R G–Dec. 8.) 1000 w.

17928. Plain and Vortex Blast Pipes. Ill. (R G–Dec. 8.) 1000 w.

17929. Heavy or Light Engines for Passenger Trains. Editorial (R G–Dec. 8.) 1800 w.

17930. The Advertising Value of Decoration. Editorial (R G–Dec. 8.) 900 w.

17931. The Siberian Railroad. Editorial (R G–Dec. 8.) 1000 w.

17933. Masonry Arches on the Stanislanworonienka Railway, Galicia. Ill. John C. Trautwine (E N–Dec. 7.) 1300 w.

17942. Storage Battery Car in Chicago. Ill. (W E–Dec. 9.) 600 w.

Serials.

7456. The Locomotive Boiler. Ill. Gustav Richard (A J R A–Began Oct. 1892—11 parts to date—30 cts. each).

12001. Rails on the Creep. Ill. A. Ewbank (J E–Began March 11—30 parts to date—45 cts. each).

14226. Railroad Rates and State Control (Tr–Began June 30—Ended Nov. 3—19 parts—30 cts. each).

15303 Steam Heating Plant for Northern Pacific Railroad Shops. Ill. (E R–Began Aug. 19—5 parts to date—15 cts. each).

15496. Railroad Coppersmithing. Ill. John Fuller, Sr. (L E–Began Sept.—4 parts to date—30 cts. each).

15824. The Development of South African Railways (E–Began Nov. 17—5 parts to date—30 cts each).

16663. The Railroad Car at the World's Columbian Exposition. Ill (R C J–Began Oct.—2 parts to date—15 cts. each).

16664. Strength of Some Materials Used in Car Building. Ill. (R C J–Began Oct.—2 parts to date—15 cts. each).

We supply copies of these articles. See introductory.

16994. The Handling of Fuel on the French, English and Belgian Railways. Ill. M. Jullian (A E R J-Began Nov—2 parts to date—30 cts. each).

17020. Construction and Inspection of Locomotive Boilers to Prevent Explosions. Ill. David L. Barnes (N C B-Began Nov.—2 parts to date—30 cts. each).

17052. The Marseilles and St. Louis Electric Road Railway. Ill. C. S. Du Riche Preller (E-Began Oct. 27—Ended Nov. 24—3 parts—30 cts. each).

17299. Motor Gearing for Electric Tramcars (E E L-Began Nov. 3—Ended Nov. 17—3 parts—30 cts. each).

17464. Vancouver to Chicago. Ill. Killingworth Hedges (I & I-Began Nov. 10—1 part to date—30 cts).

17539. The English System of Railway Signals. Edward Sauvage (A J R A-Began Nov.—1 part to date—30 cts).

17826. The Evolution of the Railway Brake. Ill. Paul Synnestvedt (R M M-Began Dec.—1 part to date—15 cts).

17850. Load Factors of Electric Tramway Plants. Frank B. Lea (E E L-Began Nov. 24—1 part to date—30 cts).

17873. The Government New Location for the Railroad Across the Main Caucasus Range. A. Zdziarski (A E R J-Began Dec—1 part to date—30 cts).

SANITARY ENGINEERING.

17216. School Sanitation. J. E. Farnham (A & B-Nov. 11.) 2400 w.

17230. Removal of Pathogenic Bacteria by Sand Filtration. (Abstract) George W. Fuller (E R-Nov. 11.) 1800 w.

*17320. Prevention of Cholera in Seaports. Editorial (E L-Nov. 3.) 750 w.

17511. Storm Water Disposal (E R-Nov 18.) 2300 w.

*17548. The Water Supply of Chicago: Its Source and Sanitary Aspects. Arthur R. Reynolds and Allen Hazen (A H-Dec.) 1600 w.

*17549. The Collection and Disposition of Animal and Vegetable Waste in the City of Milwaukee. U. O. B. Wingate (A H-Dec.) 1000 w.

17732. Necessity of a Plumbing Inspector (Met W-Dec. 2.) 750 w.

*17749. Sewerage Discussed for the Laity. John W. Hill (P-Dec.) 4200 w.

†17847. Carbon Dioxide as a Measure of the Efficiency of Ventilation. Ellen H. Richards (J A C S-Oct.) 800 w.

*17892. The Problems to be Solved in the Treatment of Hyde Park Sewage. F. W. Tuttle (J A E S-Oct.) 3000 w.

17901. Work on the Sewers of Paris. Ill. (Sc A-Dec. 9.) 1000 w.

†17948. The Blower System of Heating and Ventilation. Ill. Walter B. Snow (T Q-July) 4000 w.

†17951. On Methods Used and Results Obtained in Making Germicidal Efficiency Tests of a Disinfectant for Use in Railway Sanitation. William T. Sedgwick (T Q-July) 8000 w.

Serials.

10425. A Healthy Home. Frances Vacher (S R-Began Feb. 1—19 parts to date—30 cts. each).

14839. Water Purification in America (E N-Began Aug. 3—2 parts to date—15 cts. each).

15438. Water Filtration and Cholera. R. Koch (San-Began Sept.—Ended Dec.—4 parts—45 cts. each).

17625. Heating, Humidity and Ventilation. Joseph Nasmith (P Eng-Began Nov. 17—2 parts to date—30 cts each).

STEAM ENGINEERING.

17222. The New Shops of the Bucyrus Company. Ill. (E M J-Nov. 11.) 800 w.

17224. Water Hammer. Percival H. Seward (Met W-Nov. 11.) 5000 w.

17256. Heat and Steam.—The Units that Engineers Use (B J C-Nov. 11.) 2100 w.

17323. Lost Power. C. R. Tompkins (A S-Nov. 11.) 1300 w.

17349. On the Purification of Water Used for Steam Boilers (S V-Nov. 15.) 2000 w.

17431. Heat and Steam.—How Steam is Made. Ill. (B J C-Nov. 18.) 1300 w.

17432. About Packing.—The Kind to Use and How to Use It (B J C—Nov. 18.) 850 w.

17433. The Science of Making Steam (B J C-Nov. 18.) 1100 w.

*17499. General Theory of the Steam Engine, the Steam Jacket, and Superheated Steam. G. Leloutre (P Eng-Nov. 10.) 2600 w.

17531. The Effects on the Diagrams of Different Pipe Connections to Indicator. Ill. Edward J. Willis (A M-Nov. 23.) 1100 w.

*17540. The Flow of Steam and the Proportioning of Dry Pipes (A J R A-Nov.) 1100 w.

*17544. Hot Journals (A J R A-Nov.) 1000 w.

17571. Heat and Steam.—Expansion and the Power of Expanding Steam (B J C-Nov. 25.) 1800 w.

*17585. Cylinder Condensation and Steam Engine Economy. Leicester Allen (M W-Nov. 17.) 1700 w.

*17624. Steam Road Locomotion. William Fletcher (P Eng-Nov. 17.) 1700 w.

17716. Boiler Firing and Management. Daniel Ashworth (B J C-Dec. 2.) 1800 w.

17717. A Steam Turbine. Ill. (B J C-2.) Dec. 400 w.

17719. What Coal Shall We Use? (B J C-Dec. 2.) 1000 w.

*17758. Cylinder Compression. Harris Tabor (L E-Dec.) 1800 w.

*17780. The Slide Valve: In Eight Chapters. Ill. (S-Aug.) 2200 w.

17825. Balancing Steam Chest Slide Valves. Editorial and Letter (R M M-Dec.) 2000 w.

17912. The Coxe Furnace. Ill. (Ir-Age Dec. 7.) 2700 w.

17194. The Use of Small Sizes of Anthracite Coal for Generating Steam. Eckley B. Coxe (Ir Age-Dec. 7.) 4500 w.

17915. On the Maximum Contemporary Economy of the High Pressure Multiple Expansion Steam Engine. R. H. Thurston (Ir-Age-Dec. 7.) 2000 w.

17962. Locomotive Boilers.—Are They to Be the High-Pressure Boilers of the Future. F. W. Dean, with Editorial (B J C-Dec. 9.) 1000 w.

17963. Influence of Temperature on Chimney Draft.—Why the Draft Is Greatest at 550 Degrees (B J C-Dec. 9.) 1600 w.

17964. Coal-Saving Appliances.—Only Those Using Wastes Can Be Properly So Termed. Engineer (B J C-Dec. 9.) 700 w.

Serials.

13033. Practical Hints to Boilermakers and Templaters. Ill. (M W-Began May 12—4 parts to date—30 cts. each).

16408. Steam Plant in the New Netherland Hotel. Ill. (E R-Began Oct. 7—3 parts to date—15 cts. each).

16655. The Steam Pump. Information as to Its Classification and Characteristics (I-Began Oct. 15—4 parts to date—15 cts. each).

17292. On the Working of Steam Pumps on the Russian South-western Railways. Alexander Borodin (M W-Began Nov. 3—1 part to date—30 cts).

17685. Practical Application of the Indicator. Ill. Lewis M. Ellison (S S-Began Nov. 1—1 part to date—15 cts).

17823. Designing Corliss Gears. Ill. James Dunlop (P Eng-Began Nov. 24—1 part to date—30 cts).

17955. American Comments on English Practice. Percival H. Seward (Met W-Began Dec. 9—1 part to date—15 cts).

TELEPHONY AND TELEGRAPHY.

*17305. The Interrupted Atlantic Cables (E R L-Nov. 3.) 900 w.

17346. Breguet System of Calling Device for Telegraphic and Telephonic Purposes. Ill. (E R N Y-Nov. 18.) 400 w.

17347. Magnetic Telephony. Editorial (E R N Y-Nov. 18.) 800 w.

*17399. India Rubber for Deep Sea Insulation.—Interviews with Henry A. Reed and Willard L. Candee (I R W-Nov. 15.) 1800 w.

*17473. Indian Telegraphs in 1892-93 (El-Nov. 10.) 500 w.

17525. Telephone and Telegraph Construction in the Tropics. Ill. F. R. Hart (E E N Y-Nov. 22.) 1200 w.

17529. Self-Induction as a Remedy for Static Discharge. Ill. F. W. Jones (E E N Y-Nov. 22.) 2500 w.

*17608. The Telegraph in High Altitudes. Ill. E. O. Walker (E R L-Nov. 17.) 350 w.

17635. How Cablegrams Are Sent.—Reprint from the Philadelphia Times (M G-Nov. 25.) 800 w.

17707. Development of the Telautograph (W E-Dec. 2.) 750 w.

*17751. The Indirect Control of Telegraphs by the United States Government, with Editorial. Thomas Commerford Martine (El-Nov. 24.) 1800 w.

17896. The Bell Telephone Company's Factory, Montreal (C E N-Dec.) 900 w.

17943. American Telegraphy. R. C. Clowry—Reprint from Chicago Inter-Ocean (W E-Dec. 9.) 1500 w.

MISCELLANEOUS.

*17205. International Effects of the Fair. Edmund Mitchell, M. A. (E Mag-Jan.) 2500

*17206. Effects of the Centennial Exposition. Alfred T. Goshorn (E Mag-Jan.) 3000 w.

*17207. The Cost and Income of the Fair. Anthony F. Seeberger (E Mag-Jan.) 2000 w.

*17208. The Value of the World's Fair to the American People. Andrew Carnegie (E Mag-Jan.) 2500 w.

*17211. Designers and Organizers of the Fair. Edward C. Shankland (E Mag-Jan.) 2600 w.

*17398. The India-Rubber Outlook in Amazonia. Baron de Marajo (I R W-Nov. 15.) 2600 w.

*17401. The Early American Trade in Parà Rubber. Harry G. Johnson (I R W-Nov. 15) 800 w.

†17410. Practical and Æsthetic Principles for the Laying Out of Cities. J. Stübben (T C E-Sept.) 7000 w.

17445. Engineering Laboratories. R. C. Carpenter (Sc-Nov. 3.) 1600 w.

*17454. My Experience as a Judge at the World's Fair. M. F. O'R (E-Nov. 10.) 1800 w.

*17469. The Principles of the Calculus (El-Nov. 10.) 1000 w.

*17470. The Units of Heat and Temperature (El-Nov. 10.) 1000 w.

*17479. The Erosion of Rock Basins. Ill. T. D. La Touche (N-Nov. 9.) 2000 w.

17488. The Hawaiian Problem. Frederick E. Goodrich (B C-Nov. 18.) 800 w.

*17494. The Training of an Engineer. C. H. Scott (A L-Nov. 10.) 1800 w.

17537. Oceanography—The Pacific Bed. Richard Beynon (Sc A S-Nov. 25.) 2500 w.

17563. Concerning Useful Engineering Acquaintances. Editorial (E N-Nov. 23.) 1000 w.

*17569. A Search for Della Robbia Monuments in Italy. Ill. Allan Marquand (Sc M-Dec.) 4500 w.

*17570. Constantinople. Ill. F. Marion Crawford (Sc M-Dec.) 6000 w.

17578. Lessons from the Masters and the School of Nature. Second Lecture of John La Farge (A & B-Nov. 25) 4000 w.

We supply copies of these articles. See introductory.

*17588. Need, Not of "More Money," but of Better Exchange. T. G. Shearman (F-Dec.) 4700 w.

*17589. Some Lasting Results of the World's Fair. Alice Freeman Palmer (F-Dec.) 2800 w.

*17590. The Fair's Results to the City of Chicago. Franklin H. Head (F-Dec.) 1200 w.

†17593. Notes on Engineering in Mexico. John Birkinbine (P E C P-July.) 5800 w.

*17600. Presidential Address of John Wolfe Barry—Subject, Engineering (El-Nov. 17.) 3800 w.

*17611. The Moving Wheel. Ill. (Letters) (I C B-Nov 17.) 1300 w.

17628. The Negro's Choice—A Problem of Race, Politics and Society. R. H. Fitzhugh (B C-Nov. 25.) 1200 w.

17629. The Engineering Features of the World's Fair. Ill. (S M-Nov. 15.) 15000 w.

*17639. Presidential Addresses at the Institution of Civil Engineers. Editorial (E-Nov. 17.) 1200 w.

*17641. Technical Education. Editorial (E-Nov. 17.) 1300 w.

17689. The New Police Patrol Boat for New York City. Ill. (E N-Nov. 30.) 450 w.

†17708. The Italian Banking Crisis. Richard Dalla Volta (J P E-Dec.) 9000 w.

†17709. Labor Colonies and the Unemployed. James Mavor (J P E-Dec.) 8200 w.

†17711. Walker's Shares in Distribution. Frederick Charles Hicks (J P E-Dec.) 4000 w.

17718. Engineering in China.—Reprint from Cassier's Magazine. W. H. Fielding (B J C-Dec. 2.) 900 w.

17720. The Cotton Seed Industry (B J C-Dec. 2.) 1800 w.

17733. Trade Training for American Boys. Reprint from the Pratt Institute Monthly (Met W-Dec. 2.) 1000 w.

†17740. Can the United States Restore the Bimetallic Standard of Money to the World? George C. Douglas (A-Dec.) 4500 w.

†17742. The Financial Problem and Business Situation Discussed from a Practical Standpoint. George C. Kelley (A-Dec.) 4800 w.

*17747. Artistic Effect in Street Improvement. Frank Knight (P-Dec.) 2000 w.

17764. Considerations on the Art of Painting.—Extract from the third lecture of John La Farge (A & B-Dec. 2.) 4000 w.

†17804. Political Causes of the Business Depression. William E. Russell (N A R-Dec.) 4800 w.

†17806. Are Our Patent Laws Iniquitous? W. E. Simonds (N A R-Dec.) 2600 w.

†17808. The Hawaiian Situation. I. The Invasion of Hawaii.—Eugene Tyler Chamberlain. II. A Plea for Annexation.—John L. Stevens. III. Our Present Duty.—William M. Springer (N A R-Dec.) 8500 w.

*17824. Eastwood's "Presto" Stereotyping Matrix Process. Editorial (Inv-Nov. 25.) 2000 w.

*17840. The American Mail Service (Tr-Nov. 24.) 800 w.

*17841. Engineers of To-Day and Yesterday.—Richard Price-Williams (E Rev-Nov. 20.) 2800 w.

*17848. On Artistic Training. J. Wilson Foster (B A-Nov. 24.) 1700 w.

17889. Tortoise Shell Industry (M N-Dec. 1.) 1200 w.

*17891. Engineering the Establishment of Competitive Enterprises, with Discussion. Thomas D. West (J A E S-Oct.) 2200 w.

17903. The Mont Blanc Observatory. Ill. (Sc A-Dec. 9.) 1600 w.

17916. Utility of Gypsum in Oklahoma. J. W. Evarts (Sc A S-Dec. 9.) 1700 w.

17921. Spontaneous Combustion. Vivian B. Lewes (Sc A S-Dec. 9.) 6800 w.

17938. The Educational Value of Experimental Work. Editorial (E N-Dec. 7.) 1450 w.

17939. Engineering News Thesis Competition.—Announcement of Awards (E N-Dec. 7.) 2200 w.

†17957. Description of the Fire-Protective Arrangements in the Treasury and Imperial Secretariat Buildings, Calcutta. Ill. J. H. Toogood (I E-Nov. 4.) 600 w.

Serials.

13998. The Future of the Hot-Air Furnace. A. W. Glessner (Met W-Began July 1—Ended Nov. 18—20 parts—15 cts. each).

14545. American Universities at the World's Columbian Exposition (E-Began July 14—8 parts to date—30 cts. each).

14653. Theory vs. Practice. W. M. Patton (S-Began July—5 parts to date—30 cts. each).

16290. The Atmosphere as a Medium of Travel. Fred W. Brearey (I & I-Began Sept. 15—5 parts to date—30 cts. each).

16460. The Great Exhibition Reviewed. P. B. Wight (A A-Began Oct. 7—6 parts to date—15 cts. each).

16514. The Evolution of Artificial Light. Ill. E. L. Lomax (P A-Began Oct. 16—3 parts to date—15 cts. each).

17264. Wheels (I C B-Began Nov. 3—Ended Nov. 17—2 parts—30 cts. each).

17345. The Evolution of the Fixture Art and Decorative Illumination. Ill. Luther Stieringer (E R N Y-Began Nov. 18—Ended Nov. 29—3 parts—15 cts. each).

17369. Desquamation and Decay of Rocks and the Formation of Bowlders. Henry G. Hanks (M S P-Began Nov. 11—Ended Nov. 25—3 parts—15 cts. each).

17553. Management of Men and Manufacturing Industries. Thomas D. West (Ir Age-Began Nov. 23—2 parts to date—15 cts. each).

17682. The Silver Question. Julius Salenger (A M S-Began Oct. 28—1 part to date—30 cts).

17842. Great Works and Their Founders (E Rev-Began Nov. 20—1 part to date—30 cts).

THE TECHNICAL INDEX

A CATALOGUE OF LEADING ARTICLES PUBLISHED CURRENTLY IN THE TECHNICAL JOURNAL OF THE UNITED STATES AND GREAT BRITAIN.

THIS publication has been aptly described as "the greatest step that has been taken in recent years towards systematizing work" for the engineer, the architect, the electrician, the railway manager, and the business man. The list of publications regularly indexed will show that it covers a world-wide range of the best technical literature, and all the articles are so conveniently classified under general headings that within a few minutes an active man can learn of everything that has been published during the month in relation to his special lines of investigation. In short, it is to the practical man just what Poole's celebrated index to periodicals has long been to the literary worker, but with this essential difference,—namely, that in addition to indicating *just where* leading articles have been published, *we undertake to supply copies of the articles themselves.* The unparalleled convenience and economy of this double service can readily be appreciated.

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[In the body of the index only the initials of the journals quoted are given, and these can be readily identified by the following list of periodicals. Other abbreviations are: Ill=Illustrated. w=words.]

THE AMERICAN PRESS.

A .....Arena. *m.* $5 per year. Boston.
AA.....American Architect. *w.* $6. Boston.
Aer.....Aeronautics. *m.* $1. N. Y.
An A A..Annals of Am. Academy of Political and Social Science. *b-m.* $6. Philadelphia.
A An.... American Analyst. *f.* $1. New York.
A Ar.... American Artisan. *w.* $2. Chicago.
A & B....Architecture and Building. *w.* $6. N. Y.
A B D....Architect, Builder and Decorator. *m.* $2. Minneapolis.
A C J....Am. Chem. Journal. *b-m.* $4. Baltimore.
A E R J..Am. Eng. and Railroad Journal. *m.* $3. N. Y.
A G.....Am. Geologist. *m.* $3.50. Minneapolis.
A G L J..Am. Gas Light Journal. *w.* $3. New York.
A H.....Annals of Hygiene. *m.* $2. Phila.
A J Phar.Am. Journal of Pharmacy. *m.* $3. Phila.
A J R A..Jour. R'y. Appliances. *m.* $2. New York.
A M.....American Machinist. *w.* $3. New York.
A M & I W.Am. Man. and Iron World. $4. Pittsburg.
Am A....American Agriculturist. *m.* $1.50. N.Y.
Am S....American Shipbuilder. *w.* $2. New York.
A & N J..Army and Navy Journal. *w.* $6. New York.
A & N R..Army and Navy Register. *w.* $3. Wash'ton.
A R.....Architectural Record. *q.* $1. New York.
A Rev....Architectural Review. *s-q.* $5. Boston.
A S .....Age of Steel. *w.* $3. St. Louis.
B B.....Brick Builder. *m.* $2.50. Boston.
B C.....Boston Commonwealth. *w.* $2.50. Boston.
B G S....Bul. Am. Geog. Soc. *q.* $5. New York.
B I S.....Bul. Am. Iron and St. Asso. *w.* $4. Phila.
B J C....Boston Jour. of Commerce. *w.* $3. Boston.
B & W. .Builder and Woodworker. *m.* $3. N. Y.
C.....Compass. *m.* $1. New York.
C A.....Calif. Architect. *m.* $3. San Francisco.
Can A . Canadian Architect. *m.* $2. Toronto.
C & B... Carpentry and Building. *m.* $1. New York.
C E .....Colliery Engineer. *m.* $2. Scranton, Pa.
C E N... Canadian Elec. News. *m.* $1. Toronto.
C Eng....Canadian Engineer. *m.* $1. Montreal.
Ch.....Chautauquan. *m.* $2. Meadville, Pa.
C M.....Century Magazine. *m.* $4. New York.
Cos.... ..Cosmopolitan. *m.* $1.50. New York.
D E.....Domestic Engineering. *m.* $1. Chicago.
E A.....Electrical Age. *w.* $3. New York.
E E .....Electrical Engineering. *m.* $1. Chicago.
E E N Y..Electrical Engineer. *w.* $3. New York.
E I.....Electrical Industries. *m.* $3. Chicago.
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F D.....The Foundry. *m.* $1. Detroit.
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I R W...India Rubber World. *m.* $3. New York.
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18564. The Impedance of Mutually Inductive Circuits Containing Capacities. Ill. E. C. Rimington (E R L-Began Dec. 22—Ended Dec. 29—2 parts—30 cts. each).

18565. Experiments on Brown's Asynchronous Motors. Ill. (E R L-Began Dec. 22—1 part to date—30 cts).

18660. Electricity in the Far East. Ill. W. Stuart-Smith (E W-Began Jan. 6—1 part to date—15 cts).

18661. Alternate Current Working. Ill. Harris J. Ryan (E W-Began Jan. 6—1 part to date—15 cts).

ELECTRIC LIGHTING.

*17971. Small Electric-Light Stations. J. E. Talbot (E Mag-Feb.) 3000 w.

*18037. The Incandescent Lamp Question Once More.—What Mr. F. T. Eggers Thinks (I & I-Dec. 1.) 2200 w.

18041. Artistic Electroliers. Ill W. H Eckman (E E-Dec.) 600 w.

18066. Henry Goebel (E R N Y-Dec. 13.) 700 w.

18079. The Narragansett Station. Its Special Machinery and Unique Equipment. Ill. (E N Y-Dec. 13) 1000 w.

18084. Inert Gases in Modern Incandescent Lamps. L. K. Bohm (E W-Dec. 16.) 1500 w.

18085. The Novak Incandescent Lamp Case at Hartford. Ill. (E W-Dec. 16.) 11500 w.

18087. Frosted and Colored Incandescent Lamps. Charles Wirt (E E N Y-Dec. 13.) 1100 w.

18091. Incandescent Lamp Economics. Editorial (E E N Y-Dec. 13.) 950 w.

18093. The Inverted Arc Lamp for Interior Lighting. Ill. Benjamin A. Dobson (E E N Y-Dec. 13.) 600 w.

*18110. Electric Lighting for Carriages (Pl D-Dec. 1.) 900 w.

18145. Henry Goebel. Ill. (W E-Dec. 16.) 1400 w.

18146. Interesting Storage Battery Plant and Beacon Lamp. Ill. (W E-Dec. 16.) 900 w.

18147. Saint Lazare Depot Electric Light Station, Paris. Ill. (W E Dec. 16.) 500 w.

*18154. Direct Coupled Arc Lighting Machinery. Ill. S. B. Fortenbaugh (S J E-Dec.) 950 w.

18191. De Khotinsky's Incandescent Lamp. Ill. (E R N Y-Dec. 20.) 1000 w.

*18245. Kingston Electric Lighting Station. Ill. (E-Dec. 8.) 3100 w.

*18259. How Prof. Kennedy Proposes to Light Edinburgh (E R L-Dec. 8.) 2000 w.

*18268. Comparative Cost of Lighting by Gas and by Electricity (El-Dec. 8.) 1300 w.

18296. Electricity in a Modern Hotel. Ill. (E W-Dec. 30.) 700 w.

*18319. The Edinburgh Electric Lighting Proposal. Editorial (E R L-Dec. 15.) 600 w.

*18352. Chatsworth Lighted by Electricity (E L-Dec. 15.) 1400 w.

*18415. The Alternating Current Arc, with Editorial. Ill. (El-Dec. 15.) 2000 w.

18419. Gas and Gasoline Engines for Electric Lighting (S M-Jan. 1.) 500 w.

*18422. Electric Wiring of Buildings. Ill. W. E. J. Deming. (S R E N-Dec.) 1500 w.

18665. Light Without Heat a Possibility of the High Frequency Machine. F. Jarvis Patten (E W-Jan. 6.) 2300 w.

*18669. The Auditorium Electric Lighting Plant. Ill. (E I-Jan.) 800 w.

18672. Pioneer Electric Lighting in Montreal. John Smillie (C E N-Jan.) 2200 w.

*18709. Electric Supply Meters. Editorial (El-Dec. 29.) 1400 w.

18749. The Outcome of Practical Management. Fred. De Land (E E-Jan.) 1300 w.

Serials.

6709. Electric Light and Power. Ill. Arthur F. Guy (E E L-Began Sept. 1892—33 parts to date—30 cts. each).

13548. Arc Lighting. Ill. E. Tremlett Carter (E R L-Began June 2—13 parts to date—30 cts. each).

16631. The Scientific Study of Arc Lamps. Ill. Rankin Kennedy (E R L-Began Oct. 6—4 parts to date—30 cts. each).

18048. The Continuous Current Arc as a Standard Light. André Blondel (El-Began Dec. 1—Ended Dec. 15—3 parts—30 cts. each).

18203. A Comparison of Different Systems of Electric Lighting. Otto Frick (E W-Began Dec. 23—2 parts to date—15 cts each).

18666. The Most Economical Age of Incandescent Lamps. Manning K. Eyre (E W-Began Jan. 6—1 part to date—15 cts).

GAS ENGINEERING.

17978. The Holder Cup in Practice and in Theory. Ill. William E. McKay (A G L J-Dec. 11.) 4000 w.

17979. On Apparatus for Promoting the Interaction of Gases. Ill. George Lunge (A G L J-Dec. 11.) 5000 w.

18065. A New System of Lighting and Extinguishing Street Gas Lamps Without the Use of Wires. Ill. (E R N Y-Dec. 13.) 700 w.

18098. The Use of Peat in Gas Manufacture (P A-Dec. 15.) 600 w.

*18133. The "Lancet" Report on Gas-Stoves (J G L-Dec. 5.) 2100 w.

*18135. Oil Gas and Bye-Products from Mineral Oils, with Discussion. J. Laing (J G L-Dec. 5.) 5200 w.

*18260. The Temperature of Ignition of Explosive Gaseous Mixtures. A. E. Tutton (N-Dec. 7.) 1500 w.

*18276. Revivification of Iron Oxide. (Abstract.) George Treadway Thompson (G W-Dec. 9.) 1800 w.

*18316. American Lighting Gas. (G W-Dec. 16.) 1300 w.

*18323. Gas in the Kitchen. J. Ballantine (G E M-Dec. 10.) 1200 w.

*18458. The Removal of Tar from Gas. (Abstract.) W. Leybold (J G L-Dec. 19.) 1400 w.

*18514. Water Gas and Its Applications (G W-Dec. 23.) 1300 w.

*18531. Report on the Fatal Explosion of a Gas Cylinder at Bradford. Ill. Prof. Goodman (P Eng-Dec. 22.) 1900 w.

*18620. Inclined Retorts Successful at Brentford (J G L-Dec. 26.) 2000 w.

*18719. Oxy-Oil Gas. Editorial (Inv-Dec. 30.) 1800 w.

*18722. The Use of Coal Gas for Domestic Purposes Other than Lighting (G W-Dec. 30.) 3500 w.

18731. Oil Gas Tar. Durand Woodman (A G L J-Jan. 8) 1000 w.

18732. The Metropolitan Gas Referees on the Candles to Be Used in Testing the Lighting Value of London Gas (A G L J-Jan. 8.) 1400 w.

18733. On the Heat of Combustion of Coal Gas and Its Relation to Illuminating Power. P. Aguitton (A G L J-Jan. 8.) 3500 w.

18734. The Gas Engine as a Probable Motor in the Problem of Aerial Navigation. (Abstract.) C. W. Hastings (A G L J-Jan. 8.) 1100 w.

Serials.

13534. The Gas Engine. Ill. (M W-Began June 2—5 parts to date—30 cts. each).

17754. Tests of Gas Burners. Ill. (El-Began Nov. 24—ended Dec. 1—2 parts—30 cts. each).

HYDRAULICS.

*17972. Sand Filtration at Lawrence, Mass. Ill. George W. Fuller (E Mag-Feb.) 3000 w.

18010. Notes on Water-Power Equipment. (Abstract.) A. W. Hunking (E R-Dec. 9.) 1600 w.

*18151. Comparative Test of Hydraulic Rams. E. T. Adams and C. E. Houghton (S J E-Nov.) 300 w.

*18153. The Flow of Water Through an Orifice. Ill. S. H. Barraclough (S J E-Nov.) 1000 w.

†18340. A Description of the Hydraulic Laboratory of the Massachusetts Institute of Technology. Ill. Dwight Porter (J N E W-Dec.) 1700 w.

*18355. Water-Saving Machinery. F. M. Evanson (I C T-Dec. 15.) 900 w.

*18386. Hydraulics of Fire Streams. Ill. (E-Dec. 15.) 1500 w.

18391. Suction, as Applied to Fire Engines and Pumps. William Perry (C Eng-Dec.) 2600 w.

*18485. The Artesian Water Supply of New South Wales. (Abstract.) T. W. E. David (A P R-Nov. 16.) 1000 w.

18497. Pipe Calculations in Relation to Water Power Installations. William Cox (A M-Dec. 28.) 1400 w.

*18535. Sources of the London Water Supply. Editorial (Eng L-Dec. 22.) 1500 w.

18598. The Power Station at Niagara. Ill. (P S-Jan.) 1600 w.

†18622. A Graphic Method of Calculating Tank Capacities. Charles F. Gilbert (I E-Dec. 2.) 1100 w.

*18728. Hydraulic Power Supply. (Abstract.) E. B. Ellington (M W-Dec. 29.) 1200 w.

18735. Dubuque Water Works. Ill. (E R-Jan. 6.) 1500 w.

Serials.

16028. About Siphons. Ill. Leicester Allen (A M-Began Sept. 21—4 parts to date—15 cts. each).

16338. Hydromechanics. Ill. Frank J. Roth (S E-Began Sept.—2 parts to date—15 cts. each).

17109. The Water Supply of London. Ill. (Eng L-Began Oct. 27—Ended Dec. 29—5 parts—30 cts. each).

18396. Notes on Artesian Water, and the Effect of Irrigation on Sub-Surface Water in the San Joaquin Valley. C. E. Grunsky (E R-Began Dec. 23—1 part to date—15 cts).

18676. The Pumping Engine; Its Many Points, Faults and Peculiarities. Ill. Ernest W. Naylor (F W-Began Jan. 6—1 part to date—15 cts).

INDUSTRIAL CHEMISTRY.

†18108. The Education of Industrial Chemists. Henry Pemberton, Jr. (J A C S-Nov.) 3300 w.

Serials.

17576. Theoretical and Practical Ammonia Refrigeration. Iltyd I. Redwood (Eng-Began Nov. 25—4 parts to date—15 cts. each).

INDUSTRIAL SOCIOLOGY.

*17968. Labor's Delusion Regarding Capital. Alfred H. Peters (E Mag-Feb.) 2000 w.

*18038. The Depression of Trade and Industry; Its Causes and Its Lessons. J. Stephen Jeans (I C T-Dec. 1.) 4400 w.

18040. "Shall the Government Control the Railways and Telegraphs?" W. S. Crosby (E E-Dec.) 3800 w.

†18061. The Government and Labor. H. W. Massingham (C R-Dec.) 5000 w.

†18062. "The Economy of High Wages." J. A. Hobson (C R-Dec.) 6500 w.

†18063. Compulsory Purchase of Land in Ireland. Anthony Traill (C R-Dec.) 2200 w.

†18095. Socialism in France. Yves Guyot (N C-Dec.) 6400 w.

†18155. The Unemployed. Samuel A. Barnett (F R-Dec.) 4800 w.

18161. Labor and Society. A. B. Salom (I I G-Dec.) 1200 w.

18163. The Unequal Distribution of Capital. E. A. Holbrook (R A-Dec. 7.) 1000 w.

18180. Wages. B. F. Spalding (A S-Dec. 16.) 2500 w.

*18182. President Cleveland's Message. Editorial (Eng L-Dec. 8.) 1900 w.

18249. The New Tariff on Lead Ore. Editorial (M I T-Dec. 14.) 1500 w.

*18272. German Industrialism (A L-Dec. 8.) 1500 w.

*18273. Craft Guilds. H. H. Clutterbuck (A L-Dec. 8.) 5000 w.

18349. Ironworkers' Wages in England and the United States. Henry Tuckley (B I S-Dec. 20.) 2000 w.

*18378. London Workmen: Their Education and Workmanship. Owen Fleming (A L-Dec. 15.) 4000 w.

*18389. The Unemployed: Agencies and Methods (E-Dec. 15.) 2200 w.

*18439. Employers' Liability in Germany (J G L-Dec. 12.) 2300 w

*18457. The Labor Question in France (J G L-Dec. 19.) 2000 w.

*18486. The Progressive Land Tax Fallacy (A P R-Nov. 16.) 1500 w.

18578. The Lesson of the Panic. Thomas Stevens (Min R-Dec. 21.) 1100 w.

*18585. Relief for the Unemployed in American Cities. Albert Shaw (R of R-Jan.) 9200 w.

*18586. Relief Work,—Its Principles and Methods. Washington Gladden (R of R-Jan.) 3300 w.

†18592. How to Prevent a Money Famine. James H. Eckels (N A R-Jan.) 2500 w.

†18595. Tariff and Business. T. B. Reed (N A R-Jan.) 3700 w.

*18611. The New Tariff Bill (S Ec-Jan.) 2000 w.

*18612. The Problem of the Unemployed (S Ec-Jan.) 1200 w.

18624. Democratic Doctrine on Free Coal and Ore. Governor MacCorkle and Henry G. Davis (M R-Jan. 5.) 6300 w.

†18655. Silver in England. John Davis (A-Jan.) 5200 w.

†18656. A National Problem. C. H. Lugrin (A-Jan.) 4600 w.

*18700. The Labor Question in France (Abstract on the Settlement of Strikes). Geoffrey Drage (C G-Dec. 29.) 5800 w.

*18753. The Teaching of Our Present Economic Experiences. David A. Wells (F-Jan.) 6300 w.

*18754. The Principle and Method of the New Tariff Bill. William L. Wilson (F-Jan.) 1800 w.

*18755. The New Sectionalism · A Western Warning to the East. L. M. Keasbey (F-Jan.) 4500 w.

*18756. British Investors and American Currency Legislation (F-Jan.) 5500 w.

Serials.

17648. The Employers' Liability Bill. C. Herbert Smith (I & I-Began Nov. 17—4 parts to date—30 cts. each).

18657. Natural Monopolies and the State. Solomon Schindler (A-Began Jan.—1 part to date—45 cts).

LANDSCAPE ENGINEERING.

18241. Composition in Landscape-Art. H. A. Caparn (G & F-Dec. 20.) 1200 w.

18242. American Parks. M. C. Robbins (G & F-Dec. 20.) 1400 w.

18465. The Key-note in Landscape-gardening (G & F-Dec. 27.) 1300 w.

18568. The Preservation of Washington's Birth-place (G & F-Jan. 3.) 1600 w.

Serials.

17510. Fences (G & F-Began Nov. 22—3 parts to date—15 cts. each).

MARINE ENGINEERING

18018. Canadian Soo Canal (M Rec-Dec. 7.) 1100 w.

18019. The Worthington Condenser as Applied to Marine Engines on Lake and River Boats. Ill. (M Rec-Dec. 7.) 1000 w.

*18049. The Fleets of the Mail Lines (M E-Dec. 1.) 1800 w.

18075. Lighthouses and Their Keepers. (Abstract.) Edward P. Adams (Sc A-Dec 16.) 800 w.

18081. Review of the Birth of the Great Lakes and Their Deserted Shores. Map (Sc-Dec. 1.) 1000 w.

18131. The Old-Time Steamboat Metropolis. Ill. (Sea-Dec. 14.) 2400 w.

†18156. Sea Power: Its Past and Its Future. Nauticus (F R-Dec.) 8000 w.

18174. Coaling Ships at Sea. Ill. S. A., S. H. Riker and A. D. Adamson (Sc A S–Dec. 23.) 600 w.

*18197. The Influence of Scientific Methods on Ship-Building. (Abstract.) W. H. White (I C T–Dec. 8.) 1500 w.

*18198. Coaling Stations and Their Relations to Our Trade Routes. P. H. Colomb. (I C T–Dec. 8.) 2500 w.

*18221. The Voyage of "The Viking." Ill. Hjalmar Hjorth Boyesen (Ch–Jan.) 2200 w.

18229. A Visit to a French Flag Ship. William H. Harrison (A M–Dec. 21.) 2800 w.

*18341. Discussion of Paper by Edward P. Adams on "The Light-House System of the United States" (J A E S–Nov.) 3500 w.

18353. Raft Towing in the Lakes (M Rec–Dec. 21.) 1000 w.

*18354. Screw Propellers, Reversing Screw Propellers, and Non-Reversible Engines. Robert McGlasson (I C T–Dec. 15.) 4000 w.

18476. How and Why Foreign Steamships Pay. Richard P. Joy, with Editorial (Sea–Dec. 28.) 2300 w.

18477. American vs. English Built Steamers (Am S–Dec. 28.) 700 w.

18504. The Raddatz Submarine Boat. Ill. Richard Raddatz (M R C–Dec. 21.) 800 w.

*18512. The Manœuvring Powers of Steamships and Their Practical Applications. Ill. P. H. Colomb (N–Dec. 21.) 2800 w.

18520. The Webb Home and Academy. Ill. (M R C–Dec 28.) 1000 w.

*18533. The Port of Manchester. Ill. (Eng L–Dec 22.) 2800 w.

*18567. The Waterways of New York (Tr–Dec. 22.) 1800 w.

18648. Antarctic Exploration. (Abstract.) John Murray (Sc A S–Jan. 6.) 1300 w.

18650. "The Northwest."—New Passenger Steamer on the Great Lakes (Sea–Jan. 4.) 2800 w.

Serials.

16636. Marine Engine Design (M W–Began Oct 6—4 parts to date—30 cts. each).

18770. Subdivision of Steamships and Safety in Case of Injury. Andrew Horn (J F I–Began Jan.—1 part to date—45 cts).

MECHANICAL ENGINEERING.

18001. Transmission of Power by Ropes (M G–Dec. 9.) 700 w.

*18021. Wood-Working Machinery at Home and Abroad. Editorial (M W–Dec. 1.) 1200 w.

‡*18025. Investigation of the Stresses in a Steel Crank-shaft for a 1400 H. P. Corliss Engine. Ill. George Adams (M W–Dec. 1.) 1400 w.

18071. Picked Up in the Shop.—Some Kinks for Wood-Workers. Fred H. Colvin (A M–Dec. 14.) 1500 w.

18073. Compound Air Compression. Frank Richards (A M–Dec. 14.) 1500 w.

18092. An Innovation in Reduction Gearings. Ill. H. R. Wellman (E E N Y–Dec. 13.) 1300 w.

18175. Mechanical Equivalents. Ill. C. W. McCord (Sc A S–Dec. 23.) 1500 w.

18227. The Tool-dresser. B. F. Spalding (A M–Dec. 21.) 3300 w.

*18275. On the Whirling and Vibration of Shafts. (Abstract.) Stanley Dunkerley (P Eng–Dec. 8.) 2000 w.

18398. Notes on Belting. (Extracts.) Fred W. Taylor (S V–Dec. 15.) 2000 w.

*18441. A Revolution in Steel Barrels and Bungs. Ill. (M–Dec. 15.) 3200 w.

18498. Some Notes on Tools for Brass Work. Ill. Fred Herbert Colvin (A M–Dec. 28.) 1900 w.

18499. Bonta Glass Rolling Machine, Glass Grinding and Polishing Machine and Annealing Oven. Ill. (Sc A–Dec. 30.) 1600 w.

*18511. Cask-making Machinery. (Abstract.) Lewis H. Ransome (M W–Dec. 22.) 1000 w.

18607. The Strassburg Clock.—Wound up to Run from the Year 1840 to the Year 9999 (B J C–Jan. 6.) 700 w.

18608. Perforating Belting. C. R. Tompkins (M W–Jan. 1.) 1400 w.

18647. An Automatic Sculpturing Machine. Ill. (Sc A–Jan. 6.) 850 w.

*18687. Fifty-Ton Traveling Crane for the Cataract Construction Company, Niagara Falls, N. Y. Ill. (E–Dec. 29.) 2550 w.

*18690. Electrical Signalling by Telephotos (E–Dec. 29.) 900 w.

*18695. 160 Ton Sheer Legs, Garden Island, Sydney, N. S. W. Ill. (Eng L–Dec. 29.) 850 w.

*18723. Strength of Rim Joints in Fly-band Wheels. Ill. J. B. Stanwood (M W–Dec. 29) 1000 w.

*18743. Rope Driving. George H. Kenyon (P Eng–Dec. 29.) 4000 w.

18763. The Station Repairer. Julian A. Moses (E R N Y–Jan. 10.) 1200 w.

†18768. Practical Results Arising from the Use of Safety Devices Applied to Mechanics. John H. Cooper (J F I–Jan.) 2100 w.

*18771. Impressions of a Mechanical Engineer at the World's Columbian Exposition, with Discussion. George W. Dickie (I S F–Jan.) 5500 w.

Serials.

14879. The Battle of the Typewriters. Ill. (Inv–Began July 29—7 parts to date—30 cts. each).

16689. The Evolution of Machinery. Ill. (M–Began Oct. 15—3 parts to date—30 cts. each).

16781. Rope Driving. Ill. J. J. Flather (E W–Began Oct. 21—5 parts to date—15 cts. each).

17561. The Machine Tool Exhibit at the World's Columbian Exhibition (E N–Began Nov. 23—2 parts to date—15 cts. each).

17900. Machine Shop Milling Practice. Ill.

Horace L. Arnold (A M-Began Dec. 7—3 parts to date—15 cts. each).

17935. Results of a Nine Years Experiment on Belting. Fred W. Taylor (E N-Began Dec. 7—Ended Dec. 14—2 parts—15 cts. each).

17967. How the Ancients Moved Heavy Masses. W. F. Durfee (E Mag-Began Feb.—1 part to date—30 cts).

17990. The History and Modern Development of the Art of Interchangable Construction and Mechanism. W. F. Durfee (J F I-Began Dec.—2 parts to date—45 cts. each).

18044. Motive Power and Gearing. E. Tremlett Carter (El-Began Dec. 1—4 parts to date—30 cts. each).

18494. The "Buckeye" Valve Gear. Ill. Albert K. Mansfield (A M-Began Dec. 28—Ended Jan. 4—2 parts—15 cts. each).

METALLURGY.

*18020. The Calorific Efficiency of the Reverberatory Furnace. Major L. Cubillo (I & S-Dec. 2.) 4300 w.

*18039. The Cutlery and File Trades and the Dangers to Health Attending Them. Sinclair White (I C T-Dec. 1.) 1600 w.

18144. Carolina's Bessemer Ores. J. J. Newman (M R-Dec. 15.) 4200 w.

18179. A New Process for Manufacturing Steel Tanks. Ill. (R R-Dec. 16.) 1100 w.

*18186. General and Special Observations Concerning Ore-Dressing. O. Bilharz (C G-Dec. 8.) 4400 w.

*18196. The Dangerous Working Heat of Mild Steel, and the Effect of Annealing and Air Cooling. Joseph Nodder (I C T-Dec. 8.) 1700 w.

*18206. The Sulphuric Acid Process of Refining Lixiviation Sulphides. Frederic P. Dewey (A M S-Nov. 4.) 1200 w.

18230. Feeds and Other Matters Connected with Milling Machines. J. A. McGregor (A M-Dec. 21.) 700 w.

18235. Some Physical Characteristics of Molding Sands. Ill. Arthur J. Morse (F D-Dec.) 1700 w.

18236. The Foundry at the Fair. Thomas D. West (F D-Dec.) 4000 w.

18237. The Stove Foundry. W. J. Keep (F D-Dec.) 2600 w.

†18286. A Proposed Method of Testing Structural Steel. Ill. Alfred E. Hunt (T C E-Oct.) 6000 w.

†18287. The Use of Mild Steel for Engineering Structures. George C. Mehrtens (T C E-Oct.) 5000 w.

†18288. The Use of Basic Mild Steel as Material for Construction in Germany. C. Weyrich (T C E-Oct.) 4500 w.

*18305. Flexible Metallic Tubing (I & I-Dec. 15.) 1300 w.

*18309. British versus Spanish Iron Ores for Steel Making. Walter J. May (C G-Dec. 15.) 1000 w.

18370. Cracked Plates. Ill. (S M-Dec. 15.) 1400 w.

18393. The Economic Position of the Open Hearth Steel Furnace. H. H. Campbell (E M J-Dec. 23.) 1500 w.

18408. Ancient Hardware. A. W. Parmelee (Ir Age-Dec. 21.) 6500 w.

18427. The Cost of Roasting Ore (E M J-Dec. 30.) 1400 w.

*18452. Some Sheet Iron Work. Ill. James F. Hobart (N C B-Jan.) 700 w.

18471. Furnace vs. Foundry Practice, with Discussion. E. A. Wheeler (I T R-Dec. 28.) 4000 w.

*18705. Moulding Machines. Harris Tabor (I C T-Dec. 29.) 2600 w.

*18706. The Classification of Iron and Steel Exports. Editorial (I C T-Dec. 29.) 1300 w.

*18717. On a Method of Separating the Mineral Components of a Rock. W. J. Sollas (N-Dec. 28.) 750 w.

*18729. Fuel and Charging Iron (M W-Dec. 29.) 2500 w.

*18742. The Materials of Open-Hearth Furnaces (P Eng-Dec. 29.) 900 w.

Serials.

12714. The Practical Zinc Worker. Ill. W. J. Eden Crane (Pl D-Began May 1—8 parts to date—30 cts. each).

17566. The Forging of Eye-Bars and the Flow of Metal in Closed Dies. H. V. Loss (R G-Began Nov. 24—4 parts to date—15 cts. each).

17818. Cause of Poor Castings (T-Began Dec. 1—Ended Dec. 15—2 parts—15 cts each).

18023. On the Influence of Some Chemical Agents in Producing Injury to Iron and Steel. William Thomson (M W-Began Dec. 1—Ended Dec. 29—3 parts—30 cts. each).

18208. The Limitations of the Gold Stamp Mill. T. A. Rickard (A M S-Began Nov. 11—1 part to date—30 cts).

18392. Variations in the Milling of Gold Ores.—Amador, Cal. Ill. T. A. Rickard (E M J-Began Dec. 23—2 parts to date—15 cts. each).

18596. Annealing Sheet Iron. Ill. Ambrose Beard (Ir Age-Began Jan. 4—1 part to date—15 cts).

18627. The Chlorination of Gold Ores. L. D. Godshall (E M J-Began Jan. 6—1 part to date—15 cts).

18720. The Depression in the British Iron Ore Trade and its Remedy. Walter J. May (Inv-Began Dec. 30—1 part to date—30 cts.

MILITARY ENGINEERING.

*17974. The Fastest Cruiser in the World. Ill. Walter M. McFarland (E Mag-Feb.) 3000 w.

*17983. Triple-Expansion Engines for Turkish Gunboats. Ill. (E-Dec. 1.) 500 w.

*17985. The Capsizing of a Torpedo Boat. Editorial (E-Dec. 1). 900 w.

*17986. The "Daring" and Her Boilers. Ill. (E-Dec. 1.) 3000 w.

*17995. Admiralty Ferrules. Ill. (Eng L-Dec. 1.) 1500 w.

*17996. Artillery Experiments at Elswick (Eng L-Dec. 1.) 2200 w.

*17999. Lord Charles Beresford's New Naval Programme. Editorial (Eng L-Dec. 1.) 1600 w.

*18035. The War-Ships of the World. G. N. Arnison, Jr. (I & I-Dec. 1.) 1600 w.

†18096. Toulon and the French Navy. William Laird Clowes (N C-Dec.) 3000 w.

18132. Speed Premiums for Our War Ships. Editorial (Sea-Dec. 14.) 1200 w.

18173. The New Brazilian Navy. Ill (Sc A S-Dec. 23.) 800 w.

*18220. Military Training in Italy. A. Mosso (Ch-Jan.) 3600 w.

18231. The New American War Ship Olympia. Ill. (Sc A-Dec. 23.) 600 w.

*18328. Torpedo Boat Destroyers. Editorial (Eng L-Dec. 15.) 1650 w.

*18342. Modern Gun Making. W. H. Jaques (J A E S-Nov.) 16000 w.

*18388. Battleship Steam Trials. Editorial (E-Dec 15.) 2500 w.

*18534. The Debate on the Navy. Editorial (Eng L-Dec. 22.) 1300 w.

†18552. The Nicaragua Canal in Its Military Aspects. George P. Scriven (J M S I-Jan.) 19500 w.

†18554. The Municipal Neutrality Laws of the United States. H. C. Carbaugh (J M S I-Jan.) 3300 w.

†18555. The Evolution of Cavalry. C. A. P. Hatfield (J M S I-Jan.) 5500 w.

†18556. "Extended Order" and "Skirmish Firing" Assimilated. W. N. Blow, Jr. (J M S I-Jan.) 3700 w.

†18557. "Army Organization" (Capt. Zalinski). George W. Wingate (J M S I-Jan.) 7000 w.

†18558. The Fundamental Principles Underlying the Battle Tactics of the Different Arms. C. B. Mayne (J M S I-Jan.) 18800 w.

†18559. The Strategic Value of Canadian Railways. T. C. Scoble (J M S I-Jan.) 4000 w.

†18560. Coast Artillery Practice. J. B. Richardson (J M S I-Jan.) 10000 w.

†18561. Calvary in Future War. Col. von Walthofen (J M S I-Jan.) 8800 w.

*18570. Engines of the Italian Cruiser "Aretusa." Ill. (E-Dec. 22.) 1000 w.

*18571. The Debate on the Navy. Editorial (E-Dec. 22.) 2800 w.

*18534. The Driggs-Shrœder Rapid Firing Guns. Ill. (A E R J-Jan.) 2500 w.

†18594. Is the Value of Our Fast Cruisers Over-estimated? Daniel Ammen (N A R-Jan.) 3600 w.

18597. Progress in Naval Work Abroad. W. H. Jaques (Ir Age-Jan. 4.) 1900 w.

18651. Long Distance Riding. Ill. Charles King (Cos-Jan.)4000 w.

18677. New Engine of War (Ir Age-Jan.) 4000 w.

*18689. Warship Building (E-Dec. 29.) 1600 w.

*18694. British and French Battleships and Commerce, 1840-1874-1893 (Eng L-Dec. 29.) 800 w.

Serials.

16960. Remarks upon the Organization of the Armies of Europe. J. J. O'Connell (J M S I-Began Nov.—2 parts to date—45 cts. each).

MINING.

*17975. The Joplin Zinc Mining District. Ill. Hamilton S. Wicks (E Mag-Feb.) 3000 w.

*17988. West Australian Gold Fields. Map (Min W-Dec. 2.) 1200 w.

18000. Free Coal. Its General Advantage (M G-Dec. 9.) 2200 w.

*18013. The Washing of Coal at Small Collieries. Walter J. May (C G-Dec. 1.) 1000 w.

*18014. Gobert Congelation Plant for Shaft Sinking. Ill. J. W. P. (C G-Dec. 1.) 3300 w.

*18015. The Coalfield of Northumberland and Durham. M. E. (C G-Dec. 1.) 600 w.

18029. Cripple Creek, Colorado. Ill. (Min R-Nov. 30.) 4800 w.

*18034. The Home Salt Industry. Ill. (I & I-Dec. 1.) 2600 w.

18067. Electric Haulage in Mines. Ill. Rufus J. Foster (E R N Y-Dec. 13.) 1700 w.

18074. The Pennsylvania Anthracite Coal Fields (Sc A-Dec. 16) 800 w.

*18122. The Granite Mountain Mine. A Detailed Description of the Methods of Working a Successful Silver Mine. Ill. W. D. Dodds (C E-Dec.) 4300 w.

*18128. Salting Mines. Miner's Tricks and How to Avoid Them. Arthur Lakes (C E-Dec.) 3200 w.

18129. Faults in California Mines. Ill. W. H. Storms (M S P-Dec. 9.) 600 w.

18130. Deep Mining in Nevada City (M S P Dec 9.) 800 w.

*18134 Discussi n on Mr. John Chadwick's pap.r, "The Stacking of Coal, and Coal Haulage Machinery" (J G L-Dec. 5.) 4500 w.

18143. Free Ore and Free Coal. Edward Atkinson (M R-Dec. 15.) 3800 w.

18159. The Fisk Gold Mine (Min R-Dec. 7.) 800 w.

18160. Electricity in Mining. F. O. Blackwell (Min R-Dec. 7.) 1800 w.

*18187. The Early History of Mining in Pictou Co., Nova Scotia. Dr. Patterson (C G-Dec. 8.) 1600 w.

*18204. The Lease System of Mining in Colorado. Abstract of paper by Benjamin J. Lawrence (A M S-Nov. 4.) 950 w.

*18207. A New Gold Field. Mumuga (N S. W.) (A M S-Nov. 11.) 1400 w.

*18311. The Coal Measures of the Leen Valley. (Abstract.) James Shipman (C G-Dec. 15.) 1500 w.

18363. Needed Changes in Mining Law. M. C. Ihlseng (M S P-Dec. 16.) 1000 w.

18365. The Nevada City Mining District. E. B. P. (M S P-Dec. 16.) 3200 w.

18420. The Grass Valley Mining District. E. B. P. (M S P-Dec. 23.) 2000 w.

18500. Red Shales as Connected with the Genesis of Bitumen in California. Ill. A. S. Cooper (Sc A S-Dec. 30.) 3300 w.

*18505. The Discoveries of Coolgardie (A M S-Nov. 18.) 3100 w.

*18508. The Mistakes Made by Investors in Mines (A M S-Nov. 25.) 2500 w.

18537. Coal in Columbia. C. F. Z. Caracristi (A G L J-Jan. 1.) 700 w.

18577. Gold Mining Blunders. Editorial. (M I T-Dec. 28.) 800 w.

†18591. Are the Silver States Ruined? Davis H. Waite (N A R-Jan.) 2100 w.

18639. The Mother Lode. Stephen H. Emmens (M S P-Dec. 30.) 1800 w.

*18698. Fences for Closing Shaft Landings. Ill. M. Ichon (C G-Dec 29.) 2800 w.

*18772. Cost of Coal in California (I S F-Jan.) 800 w.

Serials.

9459. The Manufacture of Coke. Ill. John Fulton (C E-Began Jan.—12 parts to date—30 cts. each).

11282. Mine Ventilation Made Easy. W. Fairley (C E-Began March—10 parts to date—30 cts. each).

11801. Information to Aid in the Search for Gold and Silver. Ill. Arthur C. Lakes (C E-Began April—9 parts to date—30 cts. each).

11804. Fire-Damp. H. Le Chatelier. Translated by H. H. Stoek (C E-Began April—8 parts to date—30 cts. each).

12450. The Coal Fields of Canada. William Hamilton Merritt (C E-Began May—7 parts to date—30 cts. each).

16315. Gold Mining in West Australia (A M S-Began Sept. 2—8 parts to date—30 cts. each).

17255. Prospecting for Tin. Ill. A. C. Lakes (C E-Began Nov.—2 parts to date—30 cts. each).

17458. The Northumberland Coal Field. Ill. M. E. (C G-Began Nov. 10—5 parts to date—30 cts. each).

17772. Appliances Driven by Compressed Air at the Blanzy Collieries. Ill. (C G-Began Nov. 24—Ended Dec. 8—3 parts—30 cts. each).

18222. The Miner and His Perils. Albert Williams, Jr. (Ch-Began Jan.—1 part to date—30 cts).

18364. Mines on the Lower Colorado River. Taylor D. MacLeod (M S P-Began Dec. 16—Ended Dec. 23—2 parts—15 cts. each).

18579. Gases Enclosed in Coal and Coal-Dust. W. McConnell, Jr. (C G-Began Dec. 22—2 parts to date—30 cts. each).

18580. The Durham Coal Field. M. E. (C G-Began Dec. 22—2 parts to date—30 cts. each).

18640. Hydraulic Mining.—A Review of the Industry. Henry Degroot (M S P-Began Dec. 30—1 part to date—15 cts).

RAILROADING.

*17982. The Jull Centrifugal Snow Excavator at the World's Columbian Exposition. Ill. (E-Dec. 1.) 800 w.

*17984 New Railway and Tramway Schemes in Parliament. Editorial (E-Dec. 1.) 4000 w.

*17992. Hyde Park Locomotive Works, Glasgow. Ill. (R W-Nov.) 5500 w.

*18003. Some Points in Electric Traction. Editorial (E R L-Dec. 1.) 1500 w.

*18027. Train Robbery in the United States (Tr-Dec. 1.) 1000 w.

*18047. Electric Traction. Editorial (El-Dec. 1.) 1000 w.

18052. Locomotive Draft Appliances at the World's Fair. Ill. Willis C. Squire (R R-Dec. 9.) 3000 w.

18053. The Abuse of Railroad Receiverships. (Abstract. (R R-Dec. 9.) 2000 w.

18054. The Lehigh Valley Strike. L. S. Coffin (R R-Dec. 9.) 1400 w.

18064. On a Boston Platform. H. G. Tuckerman (E R N Y-Dec. 13.) 1900 w.

18076. The Broadway Cable Railway. Ill. (Sc A-Dec. 16.) 1200 w.

18101. The Chicago Elevated Loop Railroads (R G-Dec. 15) 700 w.

18104. Preventing Railroad Accidents by Law. Editorial (R G-Dec. 15.) 1800 w.

18105. Some Facts About Counterbalancing Locomotives. Editorial (R G-Dec. 15.) 1700 w.

18106. An Important Experiment in Locomotive Counterbalancing at Purdue University (R G-Dec. 15.) 2400 w.

18138. President Lincoln's Private Car. Ill. W. H. H. Price (R C J-Dec.) 1000 w.

18139. Wood Carving for Cars. Ill. Duane Doty (R C J-Dec.) 1200 w.

18140. Passenger Cars and Infectious Diseases. G. P. Conn (R C J-Dec.) 1980 w.

18142. Speed and Durability in Car Painting. George R. Cassie (R C J-Dec.) 700 w.

18162. Railway Receiverships and Foreclosures in 1893 (R A-Dec. 15.) 1000 w.

18164. Best Method of Elevating Outer Rail on Bridges. Ill. G. W. Hinman (R A-Dec. 7.) 400 w.

18176. The Movable Sidewalk at the Chicago Exposition. Ill. (Sc A S-Dec. 23.) 1800 w.

18177. A New Rotary Snow-Plow. Ill. (R R-Dec. 16.) 900 w.

*18183. Dixon's Automatic Fog Signal Apparatus, Great Northern Railway. Ill. (Eng L-Dec. 8.) 2200 w.

18192. The Broadway Cable.—Its Work and Difficulties. Julian A. Moses (E R N Y–Dec. 20.) 1100 w.

*18223. The Lake Roland Elevated. Ill. (S R R–Dec. 15.) 2000 w.

*18224. The Return Circuit of an Electric Street Railway. O. M. Rau (S R R–Dec. 15.) 2500 w.

*18226. Main Power Station of the Third Avenue Road of New York City. Ill. (S R R–Dec. 15.) 1500 w.

18238. Timely Discussion of the Best Methods of Handling Snow, by Men of Extended Experience (S R G–Dec. 16.) 5200 w.

*18256. Battery Cars in Paris. Ill. (E E L–Dec. 8.) 1000 w.

*18277. The Railways of Mexico (Tr–Dec. 8.) 1200 w.

*18318. The Position of Railway Servants in France (Tr–Dec. 15.) 1000 w.

*18324. Gas in Continental Tram Cars (G E M–Dec. 10.) 1200 w.

*18327. Electrical Tramways and the Proposed Regulations. Editorial (Eng L–Dec. 15.) 1600 w.

18332. Railroad Curves (C–Jan.) 600 w.

18351. Lubrication of Cars—Abstract of Report of Central Railway Committee (R A–Dec. 22.) 1500 w.

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18399. Pneumatic Interlocking at Buffalo. Ill. (R G–Dec. 22.) 1800 w.

18401. Construction and Inspection of Locomotive Boilers to Prevent Explosions. (Extracts) With Editorial. D. L. Barnes (R G–Dec. 22.) 12000 w.

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18428. Government Railways in a Democracy. James L. Cowles and Editorial (R R–Dec. 23.) 4000 w.

18429. New Cars of the Paris-Lyons-Mediterranean Railway. Ill. (R R–Dec. 23.) 700 w.

18430. Locomotive Boilers and their Attachments. (Abstract.) Orlando Stewart (R R–Dec. 23.) 3600 w.

18432. Methods and Practices of Railroad Receiverships (R R–Dec. 23.) 1500 w.

18446. Air Brakes and Brake Rigging. (Extract.) James Howard (R R–Dec. 30.) 2100 w.

18447. The Rowell-Potter Safety Stop and Interlocking System as Applied to Grade Crossings. Ill. (R R–Dec. 30.) 1200 w.

18449. The Rodger Ballast Car. Ill. (R R–Dec. 30.) 1350 w.

18450. Railway Receiverships—Why? Editorial (R R–Dec. 30.) 1000 w.

*18451. Passenger Car Construction. Ernest Merrick (N C B–Jan.) 2200 w.

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18463. How to Maintain the Best Track at Least Cost. G. W. Merrell (R A–Dec. 29.) 2000 w.

18464. Improvements in Locomotive Boilers. Ill. (R A–Dec. 29.) 1000 w.

18482. The Boston Subway (E N–Dec. 28.) 2800 w.

18483. Differences between American and Foreign Locomotives. (Extract.) D. L. Barnes (R G–Dec. 29.) 2200 w.

18484. Draft Appliances on Locomotives Exhibited at the World's Fair. Ill. (R G–Dec. 29.)4000 w.

18491. The Cass Avenue and Fair Grounds Electric Railway, St. Louis. Ill. (E R N Y–Dec. 27.) 800 w.

†18547. Electric Railway Construction in Philadelphia. Ill. (S R J–Jan.) 7200 w.

†18548. Comments on English Track Construction. Arthur Hodges (S R J–Jan.) 1600 w.

†18550. Notes on European Street Railway Practice G. Braet (S R J–Jan.) 2200 w.

†18551. Starting the Cable Cars on Third Ave., New York. Ill. (S R J–Jan.) 8000 w.

18601. Some Considerations of Passenger Car Framing Suggested by Recent Collisions. Ill. (R G–Jan. 5.) 2500 w.

18602. A Yard for Handling 1000 Cars a Day. Ill. W. S. Scott (R G–Jan. 5.) 1650 w.

18604. Railroad Building and Earnings in 1893. Editorial (R G–Jan. 5.) 2300 w.

*18613. Economics of the Railway Question (S Ec–Jan.) 2800 w.

*18614. The Pennsylvania "Limited." Ill. (R W–Dec.) 1800 w.

*18615. Laycock's System for Warming Railway Carriages. Ill. (R W–Dec.) 2000 w.

*18616. Some Links in Locomotive History. Ill. Clement E. Stretton (R W–Dec.) 2100 w.

*18619. Pioneer Light Railways for India. Everard Calthrop (R W–Dec.) 3600 w.

18631. An Amphibious Railway—The Camden, Gloucester and Woodbury. Ill. (E E N Y–Jan. 3.) 900 w.

18633. The Street Car Conductor. Julian A Moses (E R N Y–Jan. 3.) 1400 w.

18635. Modern Power House and Car Shed Construction. Ill. (E R N Y–Jan. 3.) 550 w.

18636. Life Guards on Street Cars. Editorial (E R N Y–Jan. 3.) 1000 w.

18667. False Economy. J. B. Cahoon (E W–Jan. 6.) 2200 w.

*18668. The Electric Lighting and Street Railway Plant, Great Falls, Montana. Ill. (E I –Jan.) 1400 w.

18679. Protecting Piles against the Teredo Navalis on the Louisville and Nashville Railroad. Michael L. Lynch (R R–Jan. 6.) 1700 w.

18680. Progress of American Railways. James W. Robertson. (Reprint from Dixie.) (R R–Jan. 6.) 1900 w.

*18681. Decision of the Air-Brake Suits (L E–Jan.) 1500 w.

*18682. Reputed and Real Condition of Compounds (L E–Jan.) 500 w.

*18683. Train Running for the Confederacy. Carter S. Anderson (L E-Jan.) 2000 w.

*18684. Growth of the Sleeping Car. Ill. (L E-Jan.) 600 w.

*18692. On the Tensile Tests of Wrought Iron Railway Axles. Thomas Andrews (Eng L-Dec. 29.) 2400 w.

18712. A Motorman's Method of Determining the Speed of His Car (S R G-Jan. 6.) 900 w.

18713. Decisions Regarding the Mutilation and Refusal of Coupon Tickets. R. D. Fisher (S R G-Jan. 6.) 1800 w.

18714. The Trans-Andine Railway—Valparaiso to Buenos Ayres. Ill. (R A-Jan. 5.) 1200 w.

*18724. Train Heating. Trials Made by the Eastern Railway of France (M W-Dec. 29.) 700 w.

18765. Electric Street Railways in New York City. Editorial (E R N Y-Jan. 10.) 850 w.

Serials.

12001. Rails on the Creep. Ill. A. Ewbank (I E-Began March 11—34 parts to date—45 cts. each).

15303. Steam Heating Plant for Northern Pacific Railroad Shops. Ill. (E R-Began Aug. 19—6 parts to date—15 cts. each).

15496. Railroad Copper-Smithing. Ill. John Fuller, Sr. (L E-Began Sept.—5 parts to date—30 cts. each).

15824. The Development of South African Railways (E-Began Sept. 1—Ended Dec. 8—7 parts—30 cts. each).

16664. The Strength of Some Materials Used in Car Building. Ill. (R C J-Began Oct. —3 parts to date—15 cts. each).

16994. The Handling of Fuel on the French, English and Belgian Railways. M. Jullian (A E R J-Began Nov.—Ended Jan.—3 parts—30 cts. each).

17197. Notes on American Railroads and Speeds. J. Pearson Pattinson (R W-Began Oct.—3 parts to date—30 cts. each).

17826. The Evolution of the Railway Brake. Ill. Paul Synnesvedt (R E M-Began Dec.—2 parts to date—15 cts. each).

17850. Load Factors of Electric Tramway Plants. Frank B. Lea (E E L-Began Nov. 24 —Ended Dec. 1—2 parts—30 cts. each).

17873. The Government New Location for the Railroad Across the Main Caucasus Range. Ill. A. Zdziarski (A E R J-Began Dec.—2 parts to date—30 cts. each).

17993. The Coming Development of Cable Traction (R W-Began Nov.—2 parts to date—30 cts. each).

18200. The Braking Question and the Emergency Stop. E. A. Merrill (E W-Began Dec. 23—2 parts to date—15 cts. each).

18225. Experiences of a Superintendent. C. P. Young (S R R-Began Dec. 15—1 part to date—30 cts.).

18387. Standard Rolling Stock on the Victorian Railways. Ill. (E-Began Dec. 15—2 parts to date—30 cts. each).

18431. The Requisites of Smooth Track: An Experiential Sketch. Phillip Noonan (R R-Began Dec. 23—Ended Dec. 30—2 parts—15 cts. each).

18435. Painting a Railway Passenger Car. A. Ashman Kelly (R E M-Began Jan.—1 part to date—15 cts.).

18549. The Intrinsic Value of Street Railway Investments. Edward E. Higgins (S R J-Began Jan.—1 part to date—45 cts.).

18566. The Railway Rates Committee's Report (Tr-Began Dec. 22—2 parts to date—30 cts. each).

18569. A New Peru (E-Began Dec. 22—Ended Dec. 29—2 parts—30 cts. each).

18678. Railroad Management. Observer (R R-Began Jan. 6—1 part to date—15 cts.).

18711. Electric Railway Motors: Their Construction and Operation. Nelson W. Perry (S R G-Began Jan. 6—1 part to date—15 cts.).

SANITARY ENGINEERING.

*17998. The Rotterdam Sewage Pumping Station and Pumping Engines. Ill. (Eng L-Dec. 1.) 1800 w.

18103. The Brainard Garbarge Crematory in Chicago. Ill. (R G-Dec. 15.) 700 w.

18233. The Traveling Garbage Burner of Chicago. Ill. (Sc A-Dec. 23.) 900 w.

*18255. Electrical Sanitation (I C B-Dec. 8.) 1100 w.

*18333. Sewage Disposal. John M. Davies (A H-Jan.) 1000 w.

18397. A Modern Disinfecting Plant. Ill. W. H. Francis (E R-Dec. 23.) 1000 w.

*18519. Some Systems of Sewage Purification. (Abstract.) W. C. Williams (I & I-Dec. 22.) 1600 w.

*18523. Ventilating Drains (I C B-Dec. 22.) 1400 w.

18542. The Salt Lake City Intercepting and Outfall Sewer. Ill. W. P. Hardesty (E N-Jan. 4.) 1800 w.

18544. Natural Filtration of Water—Mr. Kaufman's Plan (E N-Jan. 4.) 1000 w.

18546. The Partial Purification of Sewage. George E. Waring, Jr. (E N-Jan. 4.) 1800 w.

18736. A Consideration of Artesian Well and Surface Waters from the Standpoint of Bacteriology and Public Health. Timothy Matlock Cheesman (E R-Jan. 6.) 3400 w.

Serials.

5358. Sewage Purification in America (E N-Began July 14, 1892—34 parts to date—15 cts. each).

10425. A Healthy Home. Francis Vacher (S R-Began Feb. 1—22 parts to date—30 cts. each).

14839. Water Purification in America (E N-Began Aug. 3—4 parts to date—15 cts. each).

15062. The Utilization of Town Refuse for Power Production. Thomas Tomlinson (E R L-Began Aug. 4—Ended Dec. 15—9 parts—30 cts. each).

15132. A Review of Recent Plumbing Practice. G. Brown (N B-Began Aug.—3 parts to date—30 cts. each).

17625. Heating, Humidity and Ventilation. Joseph Nasmith (P Eng-Began Nov. 17—Ended Dec. 8—4 parts—30 cts. each).

STEAM ENGINEERING.

*18007. Fuel Economy. W. H. B. (E R L-Dec. 1.) 1000 w.

18056. Testing and Adjusting Steam Gauges. Ill. James F. Hobart (P S-Dec.) 1700 w.

18057. The Morgan "Compact" Engine. Ill. George I. Rockwood (P S-Dec.) 1100 w.

18058. Horse-Power of Common Tubular Boilers. Jay M. Whitham (P S-Dec.) 350 w.

18078. Oil Fuel for Boilers. Ill. (Sc A S-Dec. 16.) 350 w.

18080. Steam Piping and Efficiency of Steam Plants. William A. Pike (E N Y-Dec. 13.) 2500 w.

†18107. The Purification of Water with Special Reference to Boiler and Feed Waters and Scale Prevention. C. A. Doremus (J A C S-Nov.) 1600 w.

*18149. Graphical Method of Computing the Steam Consumption per Indicated Horse Power per Hour from the Diagram. Ill. (R. C. Carpenter (S J E-Nov.) 3500 w.

18170. Heat and Steam.—The Power of the Engine.—How to Find It (B J C-Dec. 16.) 750 w.

18171. Effect of Water in Steam (B J C-Dec. 16.) 1200 w.

18172. What Boiler to Use (B J C-Dec. 16.) 1200 w.

18178. Indifference to Boiler Firing and Management. Daniel Ainsworth (R R-Dec. 16.) 1200 w.

18232. Steam, Heat and Water. John M. Taylor (Sc A-Dec. 23.) 1650 w.

18346. The Blower System of Heating (M N-Dec. 15.) 1200 w.

18347. Coal and Petroleum Fuels (M N-Dec. 13.) 300 w.

18361. Piping Steam Engines. Ill. W. A. Pike (B J C-Dec. 23.) 2500 w.

18362. Heat and Steam.—Economy of Different Engines (B J C-Dec. 23.) 700 w.

18374. Test of a Boiler Using Grates with Small Percentage of Openings. F. A. Scheffler (Eng-Dec. 23.) 1700 w.

*18418. General Theory of the Steam Jacket, and Superheated Steam. G. Leloutre (I & S-Dec. 16.) 2600 w.

18466. About Boilers.—Different Types and Where Used (B J C-Dec. 30) 2800 w.

18467. Large Steam Pipes.—How Those at the Amoskeag Mills Are Made. Charles H. Manning (B J C-Dec. 30.) 700 w.

18468. Bituminous Coal vs. Mixed Fuel (B J C-Dec. 30.) 1150 w.

18490. The Fireman. Julian C. Moses (E R N Y-Decr 27.) 2000 w.

18536. The Existing State of the Fluid Fuel Question, with Discussion. Ill. Admiral Selwyn (A G L J-Jan. 1.) 4200 w.

18599. The Steam Engine Indicator.—The Point of Release and the Counter Pressure Line. Ill. (P S-Jan.) 2700 w.

18605. About Boilers.—How to Design One to Do a Certain Work (B J C-Jan. 6.) 2000 w.

18606. Returning Exhaust Steam to Boilers. (B J C-Jan. 6.) 800 w.

18609. Altering Valve-Seats. Ill. (M. N. Jan. 1.) 600 w.

18642. Fair Play for the Indicator. Ill. Frank Richards (A M-Jan. 4.) 2300 w.

18645. Careful vs. Careless Engineers. W. S. Wakeman (A M-Jan. 4.) 1300 w.

*18718. The Cloudy Condensation of Steam. Shelford Bidwell (N-Dec. 28.) 4000 w.

18738. Boiler Plant of Cheney Brothers' Silk Mills. Ill. (E R-Jan. 6.) 1700 w.

18751. Oil Fuel at the World's Fair. Ill. C. O. Billow (E E-Jan.) 1100 w.

Serials.

13033. Practical Hints to Boilermakers and Templaters. Ill. (M W-Began May 12—5 parts to date—30 cts. each).

16655. The Steam Pump (T-Began Oct. 15—5 parts to date—15 cts. each).

16756. Theory of Steam Engine Governors. Ill. J. Begtrup (A M-Began Oct. 19—2 parts to date—15 cts. each).

17097. Variable Eccentrics. Ill. (M W-Began Oct. 27—Ended Dec. 8—3 parts—30 cts. each).

17292. On the Working of Steam Pumps on the Russian South-Western Railways (M W-Began Nov. 3—3 parts to date—30 cts. each).

17823. Designing Corliss Valve Gears. Ill. James Dunlop (P Eng-Began Nov. 24—4 parts to date—30 cts. each).

17955. American Comments on English Practice. Ill. Percival H. Seward (Met W-Began Dec. 9—Ended Dec. 16—2 parts—15 cts. each).

18099. The Lancet Special Analytical Sanitary Commission on Smoke Prevention and Perfect Combustion (P A-Began Dec. 15—Ended Jan. 1—2 parts—15 cts. each).

18169. Power Plant in the Realty Building. Ill (E R-Began Dec. 16—1 part to date—15 cts).

18372. The Steam Engine Indicator. Jerdan Nichols (M W-Began Dec. 15—3 parts to date—30 cts. each).

18404. A Library of Steam Engineering. John Fehrenbatch (S E-Began Dec.—1 part to date—15 cts).

18405. Practical Application of the Indicator. Lewis M. Ellison (S E-Began Dec.—1 part to date—15 cts).

TELEPHONY AND TELEGRAPHY.

*18069. A New Fibrous Insulation and Its Bearing on Underground Telegraph Lines. Charles Cuttriss (E I-Dec.) 1300 w.

18194. Reducing the Capacity of Long Distance Telephone Lines by Means of Self-Induction. Max Reithoffer (E R N Y-Dec. 20.) 2000 w.

18261. The Postal Telegraph Cable Company's Storage Battery Plant in Baltimore. Ill. R. Macrae (E E N Y-Dec. 20.) 1500 w.

18263. Some Data on Cables for the Pacific. William J. Hancock (E E N Y-Dec. 20.) 800 w.

18295. A Photo-Telegraph. Ill. H. C. Johnson (E W-Dec. 30.) 1000 w.

18359. Damage for Errors in Telegraph Messages (Min R-Dec. 14.) 2000 w.

18360. Telegraph Systems—The English and American Compared (B J C-Dec. 23.) 700 w.

18470. Prospects for New Ocean Cables (W E-Dec. 30.) 1300 w.

18629. The Reed Induction System of Telegraphy. Ill. (E E N Y-Jan. 3.) 1100 w.

18637. Vancouver or Monterey.—Which Shall Be the Terminus of the French Trans-Pacific Cable? (Reprint from N. Y. *Sun*) (E R N Y-Jan. 3.) 1500 w.

18643. Practical Telephones Soon Free. S. W. Balch (A M-Jan. 4.) 1700 w.

18662. The Telephone Situation. William A. Rosenbaum (E W-Jan. 6.) 1500 w.

18750. The Evolution of the Telephone. W. Clyde Jones (E E-Jan.) 3000 w.

18758. The New Broad Street Telephone Exchange in New York. Ill. (E E N Y-Jan. 10.) 1250 w.

18766. A New Telephone Conversation Counter. Ill. (E R N Y-Jan 10.) 2000 w.

Serials.

18086. The Limitations to Long Distance Telephony. F. W. Dunbar (E E N Y-Began Dec. 13—3 parts to date—15 cts. each.)

18628. The Electro-Magnet vs. Joseph Henry's Place in the History of the Electro-Magnetic Telegraph. Ill. Mary A. Henry (E E N Y-Began Jan. 3—2 parts to date—15 cts. each).

MISCELLANEOUS.

*17969. Industrial Conditions in Mexico. John Birkinbine (E Mag-Feb.) 3000 w.

18017. The Teaching of the Industrial Arts in Italy. Alfredo Melani (A A-Dec 9.) 2300 w.

*18032. Varieties of Enamels (I C B-Dec. 1.) 1000 w.

†18042. Geologic Time; As Indicated by the Sedimentary Rocks of North America. Map. Charles D. Wolcott (A G-Dec.) 11500 w.

†18043. The Origin of Parallel and Intersecting Joints. W. O. Crosby (A G-Dec.) 2200 w.

18077. The Solution of the Flight Problem. Ill. Karl Buttenstedt (Sc A S-Dec. 16.) 900 w.

18082. World's Fair Articles by Paul Bourget, John J. Ingalls, F. Hopkinson Smith, Martha F. Crow, Robert Grant, H. H. Markley, H. H. Boyesen, H. C. Taylor, A. S. Hardy and Lyman J. Gage. Ill. (Cos-Dec.) 74000 w.

*18112. Some of the Abuses of Brushes, and Their Remedies. John J. Wheien (Pl D-Dec. 1.) 1500 w.

18115. New York and Brooklyn Bridge in 1893 (E N-Dec. 14.) 850 w.

18116. Experiments on the Mechanics of Flight. J. D. Fullerton (E N-Dec. 14.) 800 w.

*18150. A Planimeter for Averaging Radial Ordinates. W. F. Durand (S J E-Nov.) 600 w.

18168. Traction on Highways (E R-Dec. 16.) 900 w.

*18181. The Sabarmati Oil Mills of the Bombay, Baroda and Central India Railway Company. Ill. (Eng L-Dec. 8.) 800 w.

†18216. The Origin and Evolution of Property in Land. Hugh H. L. Bellot (W R-Dec.) 3700 w.

*18243. The Fayûm and Lake Moeris. Ill. (E-Dec. 8.) 4600 w.

*18248. The Romance of Dynamite. (Abstract.) Perry F. Nursey (B A-Dec. 8.) 800 w.

†18280 Typographic Surveys. Herbert G. Ogden (T C E-Oct.) 6800 w.

Serials.

9702. Modern Mosaics. Ill. Isabella Debarbieri (A R-Began Jan-March, 1893—2 parts to date—30 cts. each).

14653. Theory vs. Practice. W. M. Patton (S-Began July—6 parts to date—30 cts. each).

16290. The Atmosphere as a Medium of Travel. Fred. W. Brearey (I & I-Began Sept. 15—6 parts to date—30 cts. each).

16460. The Great Exhibition Reviewed. P. B. Wight (A A-Began Oct. 7—Ended Dec. 30—7 parts—15 cts. each).

16514. The Evolution of Artificial Light. E. L. Lomax (P A-Began Oct. 16—5 parts to date—15 cts. each).

17553. Management of Men and Manufacturing Industries. Thomas D. West (Ir Age-Began Nov. 23—4 parts to date—15 cts. each).

17570. Constantinople. Ill. F. Marion Crawford (Sc M-Began Dec.—Ended Jan.—2 parts—30 cts. each).

17682. The Silver Question. Julius Salenger (A M S-Began Oct. 28—3 parts to date—30 cts. each).

17987. British Colonies at the World's Columbian Exposition. James Dredge (E-Began Dec. 1—Ended Dec. 22—4 parts—30 cts. each).

18214. The École Des Beaux Arts. Ill. Ernest Flagg (A R-Began Jan.-March—1 part to date—30 cts).

18247. Some Practical Examples of Blasting. Ill. Perry F. Nursey (E-Began Dec. 8—Ended Dec. 29—3 parts—30 cts. each).

18379. German Art. Frederick Leighton (A L-Began Dec. 15—Ended Dec. 22—2 parts—30 cts. each).

18402. The Development and Extent of the Fertilizer Industry. Charles U. Shepard (O P D R-Began Jan 1—2 parts to date—15 cts. each).

THE TECHNICAL INDEX

A CATALOGUE OF LEADING ARTICLES PUBLISHED CURRENTLY IN THE TECHNICAL JOURNAL OF THE UNITED STATES AND GREAT BRITAIN.

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[In the body of the index only the initials of the journals quoted are given, and these can be readily identified by the following list of periodicals. Other abbreviations are: Ill=Illustrated. w=words.]

THE AMERICAN PRESS.

A .....Arena. *m.* $5 per year. Boston.
AA.....American Architect. *w.* $6. Boston.
An A A..Annals of Am. Academy of Political and Social Science. *b-m.* $6. Philadelphia.
A An.... American Analyst. *f.* $1. New York.
A Ar.... American Artisan. *w.* $2. Chicago.
A & B....Architecture and Building. *w.* $6. N. Y.
A B D....Architect, Builder and Decorator. *m.* $2. Minneapolis.
A C J....Am. Chem. Journal. *b-m.* $4. Baltimore.
A E R J..Am. Eng. and Railroad Journal. *m.*, $3. N.Y.
A G.....Am. Geologist. *m.* $3.50. Minneapolis.
A G L J..Am. Gas Light Journal. *w.* $3. New York.
A H.....Annals of Hygiene. *m.* $2. Phila.
A J Phar.Am. Journal of Pharmacy. *m.* $3. Phila.
A J R A..Jour. R'y. Appliances. *m.* $2. New York.
A M.....American Machinist. *w.* $3. New York.
A M & I W.Am. Man. and Iron World. $4. Pittsburg.
Am S....American Shipbuilder. *w.* $2. New York.
A & N J..Army and Navy Journal. *w.* $6. New York.
A & N R..Army and Navy Register. *w.* $3. Wash'ton.
A R.....Architectural Record. *q.* $1. New York.
A Rev....Architectural Review. *s-q.* $5. Boston.
A S .....Age of Steel. *w.* $3. St. Louis.
B B.....Brick Builder. *m.* $2.50. Boston.
B C.....Boston Commonwealth. *w.* $2.50. Boston.
B G S....Bul. Am. Geog. Soc. *q.* $5. New York.
B I S....Bul. Am. Iron and St. Asso. *w.* $4. Phila.
B J C....Boston Jour. of Commerce. *w.* $3. Boston.
B & W...Builder and Woodworker. *m.* $3. N. Y.
C.....Compass. *m.* $1. New York.
C A.....Calif. Architect. *m.* $3. San Francisco.
Can A..Canadian Architect. *m.* $2. Toronto.
C & B...Carpentry and Building. *m.* $1. New York.
C E .....Colliery Engineer. *m.* $2. Scranton, Pa.
C E N...Canadian Elec. News. *m.* $1. Toronto.
C Eng....Canadian Engineer. *m.* $1. Montreal.
Ch.....Chautauquan. *m.* $2. Meadville, Pa.
C M.....Century Magazine. *m.* $4. New York.
Cos.....Cosmopolitan. *m.* $1.50. New York.
D E.....Domestic Engineering. *m.* $2. Chicago.
E A.....Electrical Age. *w.* $3. New York.
E E .....Electrical Engineering. *m.* $1. Chicago.
E E N Y..Electrical Engineer. *w.* $3. New York.
E I.....Electrical Industries. *m.* $3. Chicago.
E M.....Engineering Mechanics. *m.* $2. Phila.
E Mag ...Engineering Magazine. *m.* $3. New York.
E M J....Eng. and Mining Journal. *w.* $5. N.Y.
E N.....Engineering News. *w.* $5. New York.
Eng .....Engineer. *s-m.* $2. New York.
E N Y....Electricity. *w.* $2.50. New York.
E R.....Engineering Record. *w.* $5. New York.
E R N Y..Electrical Review. *w.* $3. New York.
E & R ...Elec. and Railroading. *m.* $1. Boston.
E S W P...Proc. Eng. So. of W.Pa. *m.* $7. Pittsburg.
E W.....Electrical World. *w.* $3. New York.
F .....Forum. *m.* $3. New York.
F D.....The Foundry. *m.* $1. Detroit.
F W.....Fire and Water. *w.* $3. New York.
G & F....Garden and Forest. *w.* $4. New York.
G G M...Goldthwaite's Geograp. Mag. *m.* $2. N. Y.
G R.....Good Roads. *m.* $2. New York.

A.....Inland Architect. *m.* $5. Chicago.
I Age....Inventive Age. *s-m.* $1. Washington.
Ir Age..Iron Age. *w.* $4.50. New York.
I I G.....Iron Ind. Gazette. *m.* $1.50. Buffalo.
I R W...India Rubber World. *m.* $3. New York.
I S F.....Industry. *m.* $2. San Francisco.
I T R....Iron Trade Review. *w.* $3. Cleveland.
J A .. ..Journal of Architecture. *m.* $2. Phila.
J A C S..Jour. Am. Chem. So. *m.* $5. Easton.
J A E S..Jour. Assoc. Eng. Soc. *m.* $3. Chicago.
J A N E..Jour. Am. Soc. Naval Engineers. *qr.* $5. Washington.
J F I.....Jour. Franklin Institute. *m* $5. Phila
J M S I..Jour. Milit. Service In. *b-m.* $4. New York.
J N E W.Jour. N. E Waterw. As. *q.* $2. New London.
J P E.....Jour. Polit. Economy. *q.* $3. Chicago.
J U S A..Jour. U. S. Artillery. *q.* $2.50. Ft. Monroe.
L E.....Locomotive Engineering. *m.* $2. N. Y.
L Mag...Lippincott's Magazine. *m.* $3. Phila.
M & B...Manufacturer and Builder. *m.* $1.50. N. Y.
M & El...Mech. and Electrician. *w.* $2. St. Louis.
Met W...Metal Worker. *w.* $2. N. Y.
M G.....Manufacturer's Gazette. *w.* $2.50. Boston.
Mill.....Milling. *m.* $2. Chicago.
Min.....Minerals. *m.* $1. N. Y.
Min. R...The Mining Review. *w.* $2. Denver.
M I T....Mining Industry. *w.* $3. Denver.
M N.....Mechanical News. *s-m.* $1.50. New York.
M R.....Manufacturer's Record. *w.* $4. Baltimore.
M R C...Marine Review. *w.* $2. Cleveland, O.
M Rec....The Marine Record. *w.* $2. Cleveland.
M S P....Min. and Sci. Press. *w.* $3. San Francisco.
M S R....Mining and Sci. Review. *w.* $2. Denver.
N A R...North American Review. *m.* $5. N. Y.
N B .....National Builder. *m.* $3. Chicago.
N C B...National Car Builder. *m.* $2. New York.
N P R...Nat. Popular Review. *m.* $2.50. Chicago.
N W.....Nowest. Architect. *m.* $3. Minneapolis.
O P D R..Oil, Paint and Drug Reporter. *w.* $6. N.Y.
P..... ..Paving. *m.* $2. Indianapolis.
P A.....Progressive Age. *s-m.* $3. New York.
P E C P.Proced. Engineer's Club. *q.* $2. Phila.
S.....Power-Steam. *m.* $1. N. Y.
P S M....Popular Science Monthly. *m.* $5. N. Y.
R A.....Railway Age. *w.* $4. Chicago.
R C J....Railroad Car Journal. *m.* $1. New York.
R E M....Railway Engineering and Mechanics. *m.* $1. Chicago.
R G .....Railroad Gazette. *w.* $4.20. N. Y.
R M.....Roller Mill. *m.* $2. Buffalo, N. Y.
R of R...Review of Reviews. *m.* $2.50. New York.
R R.....Railway Review. *w.* $2. Chicago.
R & T...Roofer and Tinner. *m.* $1. N. Y.
R'y N....Railway News. *m.* $2. New York.
S... .....Stone. *m.* $2. Chicago.
S A.....Southern Architect. *m.* $2. Atlanta.
San.....Sanitarian. *m.* $4. Brooklyn.
Sc.....Science. *w.* $3.50. New York.
Sc A ....Scientific American. *w.* $3. New York.
Sc A S...Scientific Am. Supplement. *w.* $5. N. Y.
Sc M ...Scribner's Magazine. *m.* $3. New York.
S E .....Stationary Engineer. *w.* $2. Chicago.
Sc Q.....Scientific Quarterly. *q.* $2. Golden, Cal.
Sea.....Seaboard. *w.* $2. New York.
S Ec ....Social Economist. *m.* $2. New York.
S J E....Sibley Jour. of Eng. *m.* $2. Ithaca, N. Y.
S M.....Scientific Machinist. *s-m.* $1.50. Cleveland, O.
So L.....Sou. Lumberman. *s-m.* $2. Nashville.
S M Q....School of Mines Quarterly. $2. N. Y.
S R E N..St. R'y. Elec. News. *m.* $2. Minneapolis.
S P.....Sanitary Plumber. *s-m.* $1. New York.
S R G....Street Railway Gazette. *w.* $3. Chicago.
S R J....Street Railway Journal. *m.* $4. New York.
S R N. ..Street Railway News. *w.* $3. New York.
S R R.. .Street Railway Review. *m.* $2. Chicago.
S V.....Safety Valve. *m.* $1. New York.
T... ....Tradesman. *s-m.* $2. Chattanooga, Tenn.
T A I E E.Trans. Am. Ins. Elec. Eng. *m.* $5. N. Y.
T C E....Trans. Am. Soc. Civil Eng. *m.* $10. N. Y.
T Q.....Technology Quarterly. $3. Boston.
T W A—.Trans. of the Wis. Acad. Madison.
W E.....Western Electrician. *w.* $3. Chicago.
W G R..Water and Gas Review. *m.* $1. New York.

THE FOREIGN PRESS.

A L ....The Architect. *w.* 26*s.* London.
A M S.. Aust. Mining Standard. *w.* 30*s.* Sydney.
A P R...Aus. Pastoralists' Rev. *m.* 30*s.* Sydney.
B A.... .The British Architect. *w.* 23*s.* 8*d.* London.
C G.. ..Colliery Guardian. *w.* 27*s.* 6*d.* London.
C R.....Contemporary Review. *m.* $4.50. London.
C T J....Chem. Trade Jour. *w.* 12*s.* 6*d.* Manchester.
E.....Engineering. *w.* 36*s.* London.
E E L....Electrical Engineer. *w.* 19*s.* 6*d.* London.
E G.....Engineers' Gazette. *m.* 8*s.* London.
E L.....Electricity. *w.* 6*s.* 6*d.* London.
El.. .....Electrician. *w.* 24*s.* London.
EngL... Engineer. *w.* 36*s.* London.
E P .....Electrical Plant. *m.* 6*s.* London.
E Rev....Engineering Review. *m.* 7*s.* London.
E R L.....Electrical Review. *w.* 21*s.* 8*d.* London.
F R .....Fortnightly Review. *m.* $4.50. London.
G E M...Gas Engrs' Mag. *m.* 6*s.* 6*d.* Birmingham.
G W.....Gas World. *w.* 13*s.* London.
I & I.....Industries and Iron. *w.* £1. London.
I & S.....Iron and Steel Trades' Jour. *w.* 25*s.* London.
I C B.....Carpenter and Builder. *w.* 8*s.* 8*d.* London
I C T.....Iron and Coal Review. *w.* 30*s.* 4*d.* London.
I E.....Indian Engineering. *w.* 18 Rs. Calcutta.
Inv.....Invention. *w.* 28*s.* London.
I S C.....The Iron, Steel and Coal Times. *w.* £1,6*s.* London.
J G L....Journal of Gas Lighting. *w.* London.
J S A....Journal of the So. of Arts. *w.* London.
K.....Knowledge. *m.* 6*s.* London.
M.....Machinery. *m.* 9*s.* London.
M E.....Marine Engineer. *m.* 7*s.* 6*d.* London.
M E & E J. Man. Eng. and Export Jour. *m.* London.
Min W..The Mining World. *w.* 21*s.* London.
M W.....Mechanical World. *w.* 8*s.* 8*d.* London.
N..... Nature. *w.* $7. London.
N C.....Nineteenth Century. *m.* $4.50. London.
P Eng...Practical Engineer. *w.* 10*s.* London.
Pl D .....Plumber and Decor. *m.* 6*s.* 6*d.* London.
R N.....Railway News. London.
R P L....The Railway Press. *m.* 7*s.* London.
R R L...The Railway Review. *w.* London.
R W.....Railway World. *m.* 5*s.* London.
S L.....Steamship. *m.* Leith, Scotland.
S R.....Sanitary Record. *m.* 10*s.* London.
Tr.....Transport. *w.* £1. 5*s.* London.
W R.....Westminster Review. *m.* $4.50. London.

ARCHITECTURE.

*18781. The World's Fair Buildings Through French Spectacles. Jacques Hermant (E Mag–March) 3000 w.

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*19211. The Difficulties of a Young Architect. A. O. Collard (A L–Jan. 12.) 4600 w.

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19218. Manhattan Life Insurance Building, New York City. Ill. (E R–Jan. 20.) 2500 w.

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†19260. California Marble (C A–Jan.) 1800 w.

19329. Steel Chimneys for Tall Office Buildings. Ill. (E R–Feb. 3.) 400 w.

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12568. Building Construction and Superintendence. Ill. F. E. Kidder (A & B–Began May 6—19 parts to date—15 cts. each).

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17790. Vermont Marble Deposits. Ill. George C. Underhill (S–Began Sept.—4 parts to date—30 cts. each).

18737. The Engineering of Architectural and Building Construction. William H. Burr (E R–Began Jan. 6—2 parts to date—15 cts. each).

18857. Electrical Science for Architects. Russell Robb (A A–Began Jan. 13—1 part to date—15 cts).

18895. Purbeck Stone Quarries (I C B–Began Jan. 5—Ended Jan. 12—2 parts—30 cts. each).

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CIVIL ENGINEERING.

18792. Improvement of Potomac Flats, Washington, D. C. Ill. (Sc A S-Jan. 13.) 2100 w.

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18821. Wreck of Bridge Over the Yellow-Stone River, Springdale, Mont. Ill. (E N-Jan. 11.) 800 w.

†18899. Description of Frankel's Graphic Deflection-Meter. Ill. Oskar Zeuner (I E-Dec. 16.) 800 w.

*18920. Early Pavement Tiles in Ireland. (Abstract.) W. Frazer (A L-Jan. 5.) 1500 w.

*18931. Civil Engineering. Editorial (Eng L-Jan. 5.) 4000 w.

18981. New Rules for Approximate Integration. W. F. Durand (E N-Jan. 18.) 1600 w.

*19043. Bridge Over the Trent on the Midland Railway. Ill. (Eng L-Jan 12.) 400 w.

*19070. Roads in the Yellow-Stone National Park. Ill. Hiram M. Chittenden (G R-Jan.) 6700 w.

*19071. Wide Tires in Central New York. Ill. (G R-Jan.) 1000 w.

19111. The Work of Improving the Danube. Ill. (Sc A S-Jan. 27.) 1700 w.

†19115. Method Used to Secure the Stability of a Quay Wall at the Port of Altona, on the Elbe, in Germany, Which Had Shifted Its Position After Completion. Ill. Berthold Stahl (T C E-Nov.) 3000 w.

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†19123. The North and East Sea Canal. J. Fülscher (T C E-Nov.) 10600 w.

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*19198. Great Yarmouth New Fish Quay. Ill. (E-Jan. 12.) 1200 w.

*19201. Carriage-Way Pavements. Editorial (E-Jan. 12.) 1600 w.

19217. Some Experiences of a City Engineer in a Small City. (Condensed.) C. G. H. Goss (E R-Jan. 20.) 2200 w.

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19302. To Improve the Canals. Ill. (Sea-Feb. 1.) 1200 w.

19305. Engineers as Commissioners of Public Works (E N-Feb. 1.) 1300 w.

19309. The Office of City Engineer. Editorial (E N-Feb. 1.) 2000 w.

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*19321. The Hinged Suspension Bridge. Ill. Malverd A. Howe (J A E S-Dec.) 1500 w.

19325. Management of a City Engineer's Office. George A. Kimball (E R-Feb. 3.) 1600 w.

*19350. How Wheel Wear Affects the Cost of Pavements. J. M. Heiskell (P-Feb.) 1400 w.

*19351. Heavy Traffic Pavements. Emile E. Berthoud (P-Feb.) 1100 w.

*19352 Asphaltum in the United States. E. W. Parker (P-Feb.) 2000 w.

*19384. Copenhagen Breakwater. Ill. H. C. V. Moller (E-Jan. 19.) 2500 w.

†19385. Continued Discussion of E. D. Estrada's paper on "The Effects of Suddenly Applied Loads on Iron and Steel" (E S W P-Nov.) 7000 w.

*19398. Harbor Enterprise at Quebec. Ill. (Tr-Jan. 19.) 1600 w.

*19455. The Manchester Ship Canal. Ill. (E-Jan. 26.) 47500 w.

19480. Burnt Ballast. Ill. (R R-Feb. 3.) 1200 w.

†19498. Report on the Ellis Bridge over the Sabarmati River at Ahmedabad. Ill. (I E-Dec. 30.) 2200 w.

19558. The Jetties at the Mouth of the Mississippi River. William L. Elseffer (Sc A S-Feb. 10.) 1800 w.

19570. Teredo-Proof Sheathing for Piles. Ill. (E N-Feb. 8.) 1600 w.

19578. Resistance of Soils to Erosion by Water. William A. Burr (E N-Feb. 8.) 750 w.

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16520. Plant and Gear Locally Made for the Kistna Bridge. Ill. F. J. E. Spring (I E-Began Sept. 9—5 parts to date—45 cts. each).

18916. Rock Dredging Works. Gius Cimino and C. Verdinois (E-Began Jan. 5—Ended Jan. 12—2 parts—30 cts. each).

19463. Civil Engineering in the Year 1893 (E Rev-Began Jan. 20—1 part to date—30 cts).

ELECTRICAL MISCELLANY.

18830. A New Electrical Furnace.—Very High Claims for Its Efficiency Are Made (B J C-Jan. 13.) 1000 w.

18845. Relative Costs of Distribution by Different Electrical Systems with the Same Effective or Maximum E. M. F. Ill. W. D. Weaver (E W-Jan. 13.) 1300 w.

18848. Unipolar Dynamos Which Will Gen-

erate No Current. Ill. Carl Hering (E W–Jan. 13.) 1800 w.

18875. Relative Economy of Copper in Single-Phase, Two-Phase and Three-Phase Transmission. Ill. W. H. R. Emmet (E E N Y–Jan. 17.) 700 w.

18877. The Niagara Falls Electric Power Plant.—Details of Hydraulic Arrangements. Ill. (E E N Y–Jan. 17.) 800 w.

18878. Electric Chain Traction for Canals. Ill. Jules Neher (E E N Y–Jan. 17.) 500 w.

18881. Electrolysis by the Single-Phase Alternating Current. Ill. Arthur Sankey (E N Y–Jan. 17.) 1200 w.

18887. Official Report on the Tests of Electric Power on the Erie Canal. C. R. Barnes (E R N Y–Jan. 17.) 2000 w.

*18894. The Effects of Light on the Electrical Discharge. W. W. (N–Jan. 4.) 900 w.

*18926. The Influence of Electrical Inventions. (Abstract.) Thomas D. Lockwood (E L–Jan. 5.) 2200 w.

*18942. The Expense of Running Electrical Engineering Business. Sydney F. Walker (E E L–Jan. 5.) 1400 w.

19012. Influence of Temperature on Electric Batteries (E A–Jan. 20.) 800 w.

*19032, The Insulation Resistance for Home Wiring (El–Jan. 12.) 1600 w.

*19039. Electrical Engineering and Limited Liability. S. F. Walker (E E L–Jan. 12.) 1800 w.

19073. Economic Use of Transformers. W. Forman Collins (E R N Y–Jan. 24.) 2200 w.

19074. A Method of Determining Instantaneous Values of a Periodic Electromotive Force. Ill. Frederick H. Loring (E R N Y–Jan. 24.) 1300 w.

19081. Electrical Utilization of the Irish Sea Tides. Ill. W. R. Lodian (E E N Y–Jan. 24.) 750 w.

19095. Long Distance Transmission with Continuous Currents. Ill. Frank C. Perkins (E W–Jan. 27.) 1000 w.

19096. The Saving of Copper in the Three-Wire, Three-Phase System. Louis Bell (E W–Jan. 27.) 600 w.

19097. Relative Costs of Distribution by Different Electrical Systems with the Same Effective or Maximum E. M. F. A. E. Kennelly (E W–Jan. 27.) 400 w.

19098. Relative Cost of Copper for Conductors. Charles P. Steinmetz (E W–Jan. 27.) 1000 w.

19099. On the Design of Electromagnets for Specific Duty. E. R. Carichoff (E W–Jan. 27.) 800 w.

19102. Prof. H. A. Rowland vs. the Cataract Construction Company (E W–Jan. 27.) 3000 w.

19155. Advantages of Directly Connected Direct Current Generators. W. N. Stewart (W E–Jan. 27.) 1800 w.

19156. The Niagara Transmission Undertaking.—Prof. Rowland and the Niagara Construction Company (W E–Jan. 27.) 4800 w.

19157. The Trend of Electrical Investment. H. C. Thom (W E–Jan. 27.) 1400 w.

*19179. Inaugural Address of A. Siemens on the Progress of the Electrical Industry (J G L–Jan. 16.) 3600 w.

19227. The Business End of Electricity. H. C. Thom (A G L J–Jan. 22.) 2500 w.

19241. Economy in the Use of Transformers. Parmalee J. McFadden (E R N Y–Jan. 31.) 3000 w.

†19243. The Use of Steel in Electric Machines. Ill. H. F. Parshall (J F I–Feb.) 1900 w.

†19252. Nikola Tesla. Ill. Thomas C. Martin (C M–Feb.) 8000 w.

19262. The Niagara Falls Power Plant. Ill. (E W–Feb. 3.) 2000 w.

19263. Explanation of an Apparent Disagreement between Certain Magnetic Formulas. Carl Hering (E W–Feb. 3.) 1300 w.

19264. Light and Electricity after Maxwell and Hertz. (Abstract.) H. Poincare (E W–Feb. 3.) 1100 w.

19267. Electric Carriage. Ill. E. Hospitalier (Sc A–Feb. 3.) 1000 w.

19275. Aluminum Battery. Ill. Knud Bentzen (Sc A S–Feb. 3.) 1800 w.

19279. Use of the Indicator for Continuous Records in Dynamometric Testing. Ill. William S. Aldrich (A M–Feb. 1.) 3000 w.

*19283. Professor John Tyndall: A Character Sketch. Ill. Grant Allen (R of R–Feb.) 5000 w.

19303. Continuous and Alternating Current: Single and Multiphase, Bi-phase, Tri-phase, Poly-phase, etc. Ill. James F. Hobart (P S–Feb.) 2800 w.

*19388. On the Means of Increasing the Safety of High Pressure Alternate-Current Distributions. (Abstract.) Ill. G. Claude (El–Jan. 19.) 2800 w.

*19393. The Oscillations of Lightning Discharges and of the Aurora Borealis (E R L–Jan. 19.) 1000 w.

*19394. An Influence Machine, with Discussion. Ill. W. R. Pidgeon (E R L–Jan. 19.) 1800 w.

*19395. A New Form of Influence Machine. Ill. James Wimshurst (E R L–Jan. 19.) 1000 w.

*19409. Impedance in Aerial Lines and Alternate Currents. (Abstract.) M. Hospitalier (E E L–Jan. 19.) 500 w.

*19419. Belt Driven and Direct Connected Dynamos. Ill. Foree Bain (S R E N–Jan.) 600 w.

19444. The Adaptability of an Edison Three Wire Plant. Ill. James Milne (C E N–Feb.) 900 w.

*19458. The Scientific Imagination. Editorial (E R L–Jan. 26.) 1200 w.

*19459. Huddersfield Corporation Works (E R L–Jan. 26.) 2000 w.

*19464. The Recent Growth of Electricity and Electrical Applications (E Rev-Jan. 20.) 2800 w.

*19476. More Magnetic Mysteries. Ill. S. Evershed (El-Jan. 26.) 3000 w.

*19518. The Effect of Hardening Steel upon Its Electrical Resistance. Editorial (Eng L-Jan. 26.) 1400 w.

19540. An Instrument for Measuring Phase Difference. Ill. W. Stuart-Smith (E W-Feb. 10.) 1400 w.

19542. Some Unique and Useful Methods of Measurement. Ill. George T. Hanchett (E W-Feb. 10.) 950 w.

Serials.

9858. The Calculation of Alternating Current Motors. Ill. E. Arnold (E W-Began Jan. 21, 1893—6 parts to date—15 cts. each).

10464. The Silver Plating Industry. Ill. (I & I-Began Feb. 3, 1893—10 parts to date—30 cts. each).

17546. Recollections of Werner Von Siemens (E N Y-Began Nov. 22—8 parts to date—15 cts. each).

17568. Domestic Electrical Work. Ill. W. A. W. (Met W-Began Nov. 25—Ended Feb. 10—10 parts—15 cts. each).

18252. The Pull of Magnets. J. S. (I & I-Began Dec. 8—4 parts to date—30 cts. each).

18264. The Electric Transmission of Power from Niagara Falls, with Discussion. (Abstract.) George Forbes (E E N Y-Began Dec. 20—8 parts to date—15 cts. each).

18565. Experiments on Brown's Asynchronous Motors. A. Banti (E R L-Began Dec. 22—2 parts to date—30 cts. each).

18660. Electricity in the Far East. Ill. W. Stuart-Smith (E W-Began Jan. 6—3 parts to date—15 cts. each).

18661. Alternate Current Working. Ill. Harris J. Ryan (E W-Began Jan. 6—2 parts to date—15 cts. each).

18847. A New Method of Preventing Heat Radiation. R. A. Fessenden (E W-Began Jan. 13—2 parts to date—15 cts. each).

18925. Dynamo Attendants and Their Dynamos. Alfred H. Gibbings (E L-Began Jan. 5—4 parts to date—30 cts. each).

19031. A Dynamical Theory of the Electric and Luminiferous Medium. Joseph Larmor (N-Began Jan. 11—2 parts to date—30 cts. each).

19040. Faults in Dynamos. (Abstract.) J. A. Montpelier (E E L-Began Jan. 12—3 parts to date—30 cts. each).

19085. The Copper-Zinc Accumulator. Dr. Paul Schoop (E E N Y-Began Jan. 24—3 parts to date—15 cts. each).

19245. The Theory and Design of the Closed-Coil Constant Current Dynamo. Henry S. Carhart (J F I-Began Feb.—1 part to date—45 cts).

19297. Electrical Testing and Manufacturing (E N Y-Began Jan. 31—2 parts to date—15 cts. each).

19490. Notes of a Trip to the United States and Chicago, 1893. W. H. Preece (E E L-Began Jan. 26—1 part to date—30 cts).

19493. Theory of the Resistance of a Stranded Conductor. W. H. Everett (E E L-Began Jan. 26—1 part to date—30 cts).

19531. Alternating Dynamos, and Motors and Transformers. Louis Bell (E R N Y-Began Feb. 7—1 part to date—15 cts).

19541. A Brief Review of the Faraday-Maxwell-Hertzian Epoch. Ill. (E W-Began Feb. 10—1 part to date—15 cts).

ELECTRIC LIGHTING.

18842. The Central Station at Fuerstenfeld-Bruck. Ill. (W E-Jan. 13.) 600 w.

18850. A New Lamp Board. Ill. George D. Shepardson (E W-Jan. 13.) 700 w.

18883. The City of Illuminated Towers. Ill. (E N Y-Jan. 17.) 1200 w.

18884. An Electric Cloud Projector. Ill. (E R N Y-Jan. 17.) 2400 w.

18885. Judge Shipman's Decision in the "Novak" Lamp Suit. (E R N Y-Jan. 17.) 2800 w.

*19058. "Rectifiers" and Arc Lamp Circuits. Rankin Kennedy (E R L-Jan. 12.) 1000 w.

19103. Regulation of Arc Currents. Daniel Higham (E W-Jan. 27.) 1400 w.

*19223. A New Departure in Carriage Lighting. (G E M-Jan. 10.) 950 w.

19236. The Lewis System of Electric Lighting by Windmills. Ill. (E E N Y-Jan. 31.) 400 w.

19240. The Buckeye Decision. Full Text of Judge Ricks' Decision. (E R N Y-Jan. 31.) 5400 w.

19324. Corliss Compound Engines for Electric Light Work. E. L. Debell (W E-Feb. 3.) 1000 w.

*19387. The Hours of Lighting. (El-Jan. 19.) 500 w.

*19410. Electricity in the Pantomimes. Ill. (E E L-Jan. 19.) 1000 w.

19445. Notes on the Thomson-Houston Arc Dynamo. Ill. James Burnett (C E N-Feb.) 1600 w.

*19491. The Electric Light Installation at Great Eastern Railway Terminus, Liverpool Street. Ill. (E E L-Jan. 26.) 400 w.

*19517. Electric Lighting Station Accidents. Editorial (Eng L-Jan. 26.) 1700 w.

19529. A Suburban Electric Light Station. Julian A. Moses (E R N Y-Feb. 7.) 1100 w.

19539. The Novak Lamp Case. (E W-Feb. 10.) 1200 w.

Serials.

6709. Electric Light and Power. Ill. Arthur F. Guy (E E L-Began Sept 9, 1892—35 parts to date—30 cts. each).

16631. The Scientific Study of Arc Lamps. Ill. Rankin Kennedy (E R L-Began Oct. 6—5 parts to date—30 cts. each).

18666. The Most Economical Age of Incandescent Lamps. Manning K. Eyre (E W–Began Jan 6—2 parts to date—15 cts. each).

18846. Problems for Inventors in Incandescent Lighting. L. K. Bohm (E W–Began Jan. 13—2 parts to date—15 cts. each).

19415. Refuse Destructors for Electric Lighting. Report to the Shoreditch Electric Lighting Committee. (I & I–Began Jan. 19—1 part to date—30 cts.)

GAS ENGINEERING.

*18807. The Valuation of Gas Consumers. (J G L–Jan. 2.) 1550 w.

*18808. The Market for Sulphate of Ammonia During the Past Year. (J G L–Jan. 2.) 5300 w.

*18939. Gas Supply. Editorial (Eng L–Jan. 5.) 1500 w.

*18949. Some Aspects of the Competition of Gas with Other Illuminants. (J G L–Jan 9.) 3000 w.

*19051. Selection of Anthracites for Water Gas. C. R. Collins (G W–Jan. 13.) 1500 w.

*19180. New Machinery at the Bradford Road Station. (J G L–Jan 16.) 1800 w.

*19200. Inclined Retorts at the Rochdale Corporation Gas Works. Ill. (E–Jan. 12.) 2000 w.

*19222. Gas in Continental Kitchens. (G E M–Jan. 10.) 1600 w.

19271. Ammonia Motors. Ill. (Sc A S–Feb. 3.) 2500 w.

19448. Comparative Value of Coal and Coke. Messrs. Jerome and Audouin (A G L J–Feb. 5.) 1600 w.

*19525. The Technology of Coal Gas. (G W–Jan. 27.) 1200 w.

Serials.

13534. The Gas Engine. Ill. (M W–Began June 2—6 parts to date—30 cts. each).

HYDRAULICS.

*18773. City Water-Supplies of the Future. Samuel McElroy (E Mag–March) 3000 w.

†18801. Discharge of Sluices and Weirs Under Varying Heads. Ill. G. C. Maconchy (I E–Dec. 9) 850 w.

18833. Test of Pumping Engine at the Birmingham Water Works (E R–Jan. 13.) 1500 w.

18855. Progress of Development in Water Works Practice. T. W. Yardley (F W–Jan. 13.) 1400 w.

*18966. South Dakota's Wonderful Power. Artesian Wells as Water-Power. Ill. (S R R–Jan.) 1400 w.

†19116. Experiences Had During the Last Twenty-Five Years with Water Works Having an Underground Source of Supply. B. Salbach (T C E–Nov.) 13200 w.

†19118. On the Distribution of Water in the City of Mexico. L. Salazar (T C E–Nov.) 4000 w.

19136. Free Water (E N–Jan. 25.) 2800 w.

19150. Stand-Pipe Failure, East Providence, R. I. Ill. (E R–Jan 27.) 1800 w.

19151. Water Waste in Scotland (E R–Jan. 27.) 2200 w.

*19320. Irrigation.—Some Notes on the Engineering and Practical Features of the Question, with Discussion. A. M. Van Auken (J A E S–Dec.) 7000 w.

19327. The Lawrence Water Filters. Ill. (E R–Feb. 3.) 2200 w.

*19484. Derivations of Co-efficients for Calculating Size of, and Quantity Delivered by Pumps. Philip R. Bjorling (C G–Jan. 26.) 800 w.

*19495. Tangential Water Wheels. Ill. J. Richards (I S F–Feb.) 5500 w.

19571. The East Providence Stand Pipe Failure. Ill. (E N–Feb. 8.) 1350 w.

19576. Lining a Water Works Tunnel with Concrete. (Abstract.) Desmond Fitz Gerald (E N–Feb. 8.) 1500 w.

19588. Water-Works at South Haven, Mich. (F W–Feb. 10.) 2000 w.

†19597. Digest of Professor Cecil H. Peabody's Experiment with the George F. Blake Manufacturing Company's Pumping Engine Supplying Potable Water to the City of Newton, Mass. Chief Eng. Isherwood (J A N E–Nov.) 11500 w.

Serials.

18396. Notes on Artesian Water, and the Effect of Irrigation on Sub-Surface Water in the San Joaquin Valley. C. E. Grunsky (E R–Began Dec. 23—3 parts to date—15 cts. each).

18676 The Pumping Engine; Its Many Points, Faults and Peculiarities. Ernest W. Naylor (F W–Began Jan. 6—5 parts to date—15 cts. each).

18985. Water Waste Prevention, or Increased Pumping Capacity.—Investigations of Henry S. Maddock (E N–Began Jan. 18—Ended Jan. 25—2 parts—15 cts. each).

INDUSTRIAL CHEMISTRY.

*18935. Chemical Industry. Editorial (Eng L–Jan. 5.) 1200 w.

*19207. The Progress of Chemical Industry in 1893 (I & I–Jan. 12.) 5000 w.

†19242. Artificial Refrigeration Through Street Pipe Lines from Central Stations. Ill. David Branson (J F I–Feb.) 4000 w.

*19376. The Manchester Technical Laboratory. Ill. (C T J–Jan. 20.) 1300 w.

*19416. The New Rules for Chemical Works (I & I–Jan. 19.) 600 w.

19554. A Large Philadelphia Ice Making Plant. Ill. (Sc A–Feb. 10.) 750 w.

Serials.

11891. Water Analysis. George C. Tilden (Sc Q–Began March—2 parts to date—45 cts. each).

17576. Theoretical and Practical Ammonia Refrigeration. Iltyd I. Redwood (Eng–Began Nov. 25—6 parts to date—15 cts. each).

INDUSTRIAL SOCIOLOGY.

†18794. The Coal Strike of 1893. Emerson Bainbridge (C R–Jan.) 5700 w.

†18795. A Living Wage. W. Cunningham. (C R–Jan.) 6000 w.

†18798. The Drift to Socialism. A. Dunn-Gardner (C R–Jan.) 1500 w.

†18838. The Employment of Women.—The Lady Assistant Commissioner's Report. A. Amy Bulley (F R–Jan.) 4700 w.

*18922. Arbitration and Conciliation in Labor Disputes (I C T–Jan. 5.) 1200 w.

†18947. The Principles of Exclusive Individual Ownership in Land. H. H. L. Bellot (W R–Jan.) 3800 w.

*18976. A Conversation with a Labor Leader. (Ch–Feb.) 3000 w.

*19044. Government and the Eight Hours' Day. Editorial (Eng L–Jan. 12.) 1800 w.

19067. The Spirit of the Strike. A. B. Salom (I I G–Jan.) 1350 w.

*19087. Methods of Relief for the Unemployed. Josephine Shaw Lowell (F–Feb.) 3400 w.

*19093. Incomes of the Professional Classes in England. Price Collier (F–Feb.) 3300 w.

19147. Does New England Want Free Coal? (B J C–Jan. 27.) 1200 w.

19149. M. E. Ingalls Points Out Some of the Mistakes of the Wilson Bill (M R–Jan. 26.) 3600 w.

19195. Union of Capital and Labor. Editorial (B J C–Jan. 20.) 700 w.

*19202. Dangerous Occupations. Editorial (E–Jan. 12.) 2000 w.

†19287. How to Help the Unemployed. Henry George (N A R–Feb.) 4000 w.

†19290. The Customs Administrative Act. (N A R–Feb.) 3500 w.

†19291. The Wilson Bill. Roger Q. Mills (N A R–Feb.) 4200 w.

*19353. Public Work for the Unemployed (P–Feb.) 2600 w.

*19354. The Delusion About Prices (S Ec–Feb.) 3800 w.

*19355. A "Revenue Only" Tariff Unconstitutional (S Ec–Feb.) 2200 w.

*19356. What Shall We Do with the Unemployed (S Ec–Feb.) 1000 w.

†19452. Views of Rubber Men on the Tariff Changes (I R W–Jan. 15.) 5000 w.

*19524. Industrial Combinations to Keep Up Prices (I C T–Jan. 26.) 1600 w.

19551. Through Profit Sharing to Co-operation. N. O. Nelson—in Employer and Employed (A M–Feb. 8.) 4800 w.

LANDSCAPE ENGINEERING.

18787. Work for the Municipal Art Society (G & F–Jan. 10.) 1200 w.

18888. Street Trees (G & F–Jan. 17.) 900 w.

18889. Boston's New Metropolitan Parks. Sylvester Baxter (G & F–Jan. 17.) 1100 w.

19261. A German View of Landscape-Art in America (G & F–Jan. 31.) 1000 w.

Serials.

19346. Public Squares. Ill. T. M. Newton (A A–Began Feb. 3—1 part to date—15 cts).

MARINE ENGINEERING.

*18800. Comparing and Estimating Steamship Performances. (Abstract.) W. Hök (S L–Jan.) 3600 w.

*18805. The Steamship "Gothic." W. N. B. (Pl D–Jan. 1.) 1000 w.

18825. Pioneer Iron Steamers. Ill. (Sea–Jan. 11.) 3500 w.

18851. Draining the Lakes. (Abstract.) G. F. Wright (M Rec–Jan. 11.) 2400 w.

18852. Compass Deviation in Metal Steamers. Editorial (M Rec–Jan. 11.) 900 w.

†18863. The Manchester Ship Canal. Map. Egarton of Tatton (N C–Jan.) 4800 w.

18871. The Cruise of the Clover. Remarks on the Aberrations of Audibility of Fog Signals.—The Methods Used. Arnold Burges Johnson (Sc–Jan. 5.) 4500 w.

*18893. Navigation by Semi-Azimuths.—System of Ernest Wentworth Buller (N–Jan. 4.) 1800 w.

*18936. Harbors and Waterways. Editorial (Eng L–Jan. 5.) 2100 w.

19009. Brief Rules for the Use of Oil at Sea. (Extracts.) Ill. R. Karlowa (Sea–Jan. 18.) 500 w.

19010. White Lights Must Prevail. Ill. (Sea–Jan. 18.) 2200 w.

19060. Steel Screw Steamer for the Lakes. Ill. (M R C–Jan. 18.) 1800 w.

19061. A Model Bridge Bill (M R C–Jan. 18.) 1600 w.

19068. All About Aluminum.—Its Use in Yacht Building (I I G–Jan.) 1100 w.

19069. White Wings on the Blue Sea. (Extracts.) Joseph R. Oldham (M Rec–Jan. 18.) 5000 w.

19108. The American Line's New Twin-Screw Steamer "St. Louis." Ill. (Am S–Jan. 25.) 1200 w.

†19113. The Plant of Maritime Commercial Ports of France. Ill. H. Despres (T C E–Nov.) 7500 w.

†19114. The Development of Quay-Cranes in the Port of Hamburg. Ill. Chr. Nehls (T C E–Nov. 7000 w.

19126. An American Lighthouse. Ill. (Ir Age–Jan. 25.) 600 w.

19128. To Ruin American Marine Engine Builders.—Foreign Built Marine Engines to be Admitted Free of Duty (Sea–Jan. 25.) 1800 w.

19129. Against the Free Ship Bill (Sea–Jan. 25.) 1500 w.

19131. Some Thoughts on Ferry Boats. (Abstract.) Edwin A. Stevens (R G–Jan. 26.) 2000 w.

19175. Important Ship Canals.—Relation of

Our Great Inland Waterway to the Proposed Nicaragua Canal (M R C–Jan. 25.) 2000 w.

*19224. Opening of the Great Lancashire Waterway (G E M–Jan. 10.) 3800 w.

19270. The Submarine Boat Gymnote. Ill. (Sc A S–Feb. 3.) 700 w.

*19292. Apparatus for Rapid Loading of Coal into Ships. Ill. G. Braet (A E R J–Feb.) 2000 w.

19316. History of the Sault Canal. (Reprint from Duluth News-Tribune.) (M Rec–Feb. 1.) 1800 w.

†19366. How the Sea Is Sounded. Ill. G. W. Littlehales (P S M–Jan.) 2200 w.

†19367. Uncle Sam's Life Savers. Ill. Frank G. Carpenter (P S M–Jan.) 2000 w.

†19371. Physical Conditions of the Deep Sea. Sidney J. Hickson (P S M–Feb.) 3500 w.

*19381. The Surplus of Shipping. Editorial (E–Jan. 19.) 2000 w.

*19382. Captain Wiggins' Expedition to the River Yenisei, Siberia. William Byford (E–Jan. 19.) 3500 w.

*19397. Lloyd's Register Shipbuilding Returns (Tr–Jan. 19.) 1600 w.

*19425. Steamship Performance. Editorial (Eng L–Jan. 19.) 1000 w.

*19431. The Philosophy of the Steamship. (Reprint from Cassier's Magazine.) E. Durand (E G–Jan.) 4000 w.

*19456. The Navigation of the Severn. Editorial (E–Jan. 26.) 1700 w.

*19465. Shipbuilding and Marine Engineering in 1893.—With Special Reference to Atlantic Navigation (E Rev–Jan. 20.) 1400 w.

*19494. The Training of Mercantile Marine Engineers. J. R. Fothergill (P Eng–Jan. 26.) 5000 w.

*19513. Aluminum in Shipbuilding (I & S–Jan. 27.) 1300 w.

19579. Deck Houses on Ocean Steamers. Benny Bernstein (Am S–Feb. 8.) 600 w.

†19598. Fast Ocean Steamships. Ill. Francis Elgar (J A N E–Nov.) 8000 w.

†19599. Some Experiments on the Combination of Induced Draft and Hot Air, Applied to Marine Boilers Fitted with "Serve" Tubes and Retarders, with Discussion. Ill. J. D. Ellis (J A N E–Nov.) 5000 w.

†19601. On the Measurement of Wake Currents. Ill. George A. Calvert (J A N E–Nov.) 5000 w.

†19602. The Motive Power of Small Vessels. (Reprinted from "The Engineer.") J A N E–Nov.) 3000 w.

†19603. Marine Boiler Construction. C. E. Stromeyer (J A N E–Nov.) 3500 w.

†19606. On the Present Position of Water-Tube Boilers as Applied for Marine Purposes, with Discussion. Ill. J. T. Milton (J A N E–Nov.) 10000 w.

†19608. Engine Vibration. Ill. J. A. Normand (J A N E–Nov.) 2500 w.

†19610. The 1893 Contest for the America's Cup. Ill. (J A N E–Nov.) 8800 w.

Serials.

18770. Subdivision of Steamships and Safety in Case of Injury. Ill. Andrew Ham (J F I–Began Jan.—Ended Feb.—2 parts—45 cts. each).

18913. Shipbuilding and Marine Engineering in 1893 (E–Began Jan. 5—Ended Jan. 19—3 parts—30 cts. each).

19094. On Piratical Seas.—A Merchant's Voyage to the West Indies in 1805. Peter A. Grotjan (Sc M–Began Feb.—1 part to date—30 cts).

MECHANICAL ENGINEERING.

18791. The "Linotype." Ill. (Sc A–Feb. 13.) 1800 w.

18829. American Built Machinery.—Inconsistency of Some Mill Managers. Granite (B J C–Jan. 13.) 1350 w.

*18932. Mechanical Engineering. Editorial (Eng L–Jan. 5.) 8000 w.

19105. The Use of Drawbacks and Grids. Ill. J. H. (A M–Jan. 25.) 1800 w.

†19170. Description of Fränkel's Recording Extenso-Meter. Ill. (J E–Dec. 23.) 1300 w.

19206. Report of Committee of American Society of Mechanical Engineers, on a Standard Method of Conducting Locomotive Tests (Eng.–Jan. 20.) 4800 w.

19216. Wire Rope Transmission. Alexander R. Greig (C Eng–Jan.) 1500 w.

19231. Sharpening a Corner Chisel. Ill. James Francis (C & B–Feb.) 1100 w.

19276. The Safety Element in Fly-wheel Construction. Joseph Torrey (A M–Feb. 1.) 1650 w.

19277. A Rule for Laying Out Driver Brakes of the Cam or "Spread" Variety. Ill. William H. Ford (A M–Feb. 1.) 400 w.

19278. Compound Air Compression and Inter-cooling. Frank Richards (A M–Feb. 1.) 1600 w.

19282. A Criticism of American Machinery (Ir Age–Feb. 1.) 1200 w.

*19295. The Norwalk Compound Air Compressor. Ill. (A E R J–Feb.) 2000 w.

19301. Machinery and Progress. Editorial (T–Feb. 1.) 1100 w.

*19317. Experiments on the Compressive Strength of Steel Hoops, with Discussion. Ill. Charles H. Benjamin (J A E S–Dec.) 2800 w.

*19319. The Ferris Wheel, with Discussion. William H. Searles (J A E S–Dec.) 4500 w.

†19344. Some Novelties in Bevel Gearing. Max Uhlmann (E S W P–Jan.) 2700 w.

*19430. Estimating for Mechanical Work. T. Daniels (M W–Jan. 19.) 2300 w.

*19435. Pattern Making (I C B–Jan. 19.) 1500 w.

*19438. Wheels (I C B–Jan. 19.) 1900 w.

19549. A Cost-Keeping System. Walter B. Snow (A M–Feb. 8.) 3000 w.

†19605. Modern Cranes. Ill. B. H. Warren (J A N E-Nov.) 4000 w.

Serials.

16781. Rope Driving. Ill. J. J. Flather (E W-Began Oct. 21—8 parts to date—15 cts. each).

17362. Arithmetic of the Screw and of Symmetrical Rings. Ill. Leicester Allen (A M-Began Nov. 16—2 parts to date—15 cts. each).

17900. Machine Shop Milling Practice. Ill. Horace L. Arnold (A M-Began Dec. 7—5 parts to date—15 cts. each).

17967. How the Ancients Moved Heavy Masses. Ill. W. F. Durfee (E Mag-Began Feb.—2 parts to date—30 cts. each).

17990. The History and Modern Development of the Art of Interchangeable Construction in Mechanism. W. F. Durfee (J F I-Began Dec.—Ended Feb.—3 parts—45 cts. each).

18044. Motive Power and Gearing. Ill. E. Tremlett Carter (El-Began Dec. 1—6 parts to date—30 cts each).

18944. Cranes and Crabs (E E L-Began Jan. 5—Ended Feb. 12—2 parts—30 cts. each).

18963. Notes on Belting. Fred W. Taylor (A M-Began Jan. 18—Ended Jan. 25—2 parts —15 cts. each).

METALLURGY.

*18775. The American Practice in Silver-Lead Smelting. Ill, Walter Renton Ingalls (E Mag-March) 3500 w.

†18783. Purchasing Silver, Gold and Lead Ores. H. Van F. Furman (S M Q-Nov.) 2000 w.

†18784. A Primitive Smelting-Furnace. Ill. Robert Peele, Jr. (S M Q-Nov.) 1000 w.

18874. The Practical Economy of Electric Heat Compared with the Blast Furnace. Isaiah L. Roberts (E E N Y-Jan. 17.) 1800 w.

*18902. The Waste of Heat, Past, Present and Future in Smelting Ores of Iron. (Abstract). Lowthian Bell (I & I-Jan. 5.) 6800 w.

*18907. Machinery Required in Iron Ore Concentration. Walter J. May (C G-Jan. 5.) 2300 w.

*18921. The Effects of the Coal Strike on the Iron Industry (I C T-Jan. 5.) 1800 w.

*18928. Cleveland Iron and Steel Trades (I & S-Jan. 6.) 2000 w.

*18934. Metallurgy. Editorial (Eng L-Jan. 5.) 1900 w.

*18953. A New Method of Separating Gold from Pure Amalgam. J. C. F. Johnson (A M S-Dec. 9.) 500 w.

*18955. A New Gold-Saving Process.—Sutton's Centrifugal Chlorinator. Ill. (A M S-Dec. 16.) 800 w.

*18956. The MacArthur Cyanide Process in South Australia.—Adopted at Wadnaminga (A M S-Dec. 16.) 2200 w.

18964. Sulphur in the Basic Bessemer Process. J. E. Thompson (Ir Age-Jan. 18.) 2100 w.

18973. Iron in the South.—The Cause of Depression and Source of Recovery. George H. Hull (T-Jan. 15.) 1400 w.

19024. Pig Iron.—The Effect of the Wilson Bill in the South. M. Erskine Miller (M R-Jan. 19.) 800 w.

19025. Researches in the Properties of Alloys. Ill. W. C. Roberts-Austen (E M J-Jan. 20.) 2500 w.

*19049. Concentrating and Sizing of Crushed Minerals. (Abstract.) Robert E. Commans (C G-Jan. 12.) 1500 w.

19125. Tin Mill Practice. Ill. (Ir Age-Jan. 25) 2000 w.

19142. The Modern Practice of Chlorination. H. J. Jory (E M J-Jan. 27.) 2000 w.

19143. The Composition of Lead Slags. L S. Austin (E M J-Jan. 27.) 1000 w.

19280 "Coke," with Discussion. C. K. Pittman (Ir Age-Feb. 1.) 6700 w.

†19370. The Past and Future of Aluminum. M. J. Fleury (P S M-Jan.) 2500 w.

*19390. Iron Making in Novia Scotia Early in the Century. H. S. Poole (I & S-Jan. 20.) 2700 w.

*19403. Germany as a Pig Iron Producing Country (C G-Jan. 19.) 1000 w.

*19404. A Modification of Siemens' Gas Reversing Valve for Steel Furnaces. (Abstract.) John Barr (I C T-Jan 19.) 800 w.

*19411. Metallurgical Progress in 1893 (I & I-Jan. 19.) 3400 w.

*19434. Early English Iron. W. J. Eden Crane (I C B-Jan. 19.) 1300 w.

*19436. Bent Ironwork. Ill. (I C B-Jan. 19.) 800 w.

*19437. Cast Iron Columns and Stanchions. George H. Blagrove (I C B-Jan. 19.) 1100 w.

19440. High Grade Ores and Slag Production. Walter J. May (A M & I W-Feb. 2.) 900 w.

†19469. The Assay of Gold. T. K. Rose (Sc Q-Jan.) 1000 w.

†19475. Proposed Standard Methods. Ill. (Extract.) C. B. Dudley and F. N. Pease (Sc Q-Jan.) 9000 w.

*19485. The New Taussig System of Treating Metals and Ores (C G-Jan. 26.) 1300 w.

*19488. The Removal of Sand from Fine Adhesive Iron Ores. Walter J. May (C G-Jan. 26.) 800 w.

*19521. Sulphur in Cast Iron.—Objections to Mr. Keep's Conclusions (I C T-Jan. 26) 1800 w.

19562. The Development of the Iron and Steel Roofing Industry. Ill. (Ir Age-Feb. 8.) 4000 w.

19589. Foundry Chemistry. W. J. Keep (I T R-Feb. 8.) 1500 w.

Serials.

12714. The Practical Zinc Worker. Ill. W. J. Eden Crane (Pl D-Began May 1—Ended Jan. 1—9 parts—30 cts. each).

12868. Present Condition of the Mechanica

Preparation of Ores in Saxony, Hartz and Rhenish Prussia. M. Maurice Bellom (S M Q–Began April—3 parts to date—45 cts. each).

17566. The Forging of Eye-Bars and the Flow of Metal in Closed Dies. H. V. Loss (R G–Began Nov. 24—Ended Jan. 19—5 parts —15 cts. each).

18208. The Limitations of the Gold Stamp Mill. T. A. Rickard (A M S–Began Nov. 11—2 parts to date—30 cts. each).

18596. Annealing Sheet Iron. Ill. Ambrose Beard (Ir Age–Began Jan. 4—Ended Jan. 11—2 parts—15 cts. each).

18627. The Chlorination of Gold Ores. L. D. Godshall (E M J–Began Jan. 6—Ended Jan. 13 —2 parts—15 cts. each).

18720. The Depression in the British Iron Ore Trade and Its Remedy. Walter J. May (Inv–Began Dec. 30—Ended Jan. 6—2 parts—30 cts. each).

18900. The Protection of Iron and Steel from Corrosion. Ill. (I & I–Began Jan. 5—1 part to date—30 cts).

18903. The Present and Future of Steel in Belgium. (C G–Began Jan. 5—2 parts to date —30 cts. each).

18965. Aluminum: Its Properties and Its Uses. Alfred E. Hunt (Ir Age—Began Jan. 18 —2 parts to date—15 cts. each).

19145. Cupola Management. Edward Kirk (Met W–Began Jan. 27—3 parts to date—15 cts. each).

19215. Canadian Iron Industry. George E. Drummond (C Eng–Began Jan.—1 part to date —15 cts.).

19300. Elasticity and Fluidity.—The Effect of an Increase of Knowledge of these Properties (T–Began Feb. 1—1 part to date—15 cts).

19336. Gold Mining in Australasia. T. A. Rickard (E M J–Began Feb. 3—1 part to date—15 cts).

19405. Progress Made in Coking During the Last Few Years. R. de Soldenhoff (I C T–Began Jan. 19—Ended Jan. 26—2 parts– 30 cts. each).

19482. A New Process for the Production of Pig Iron, Refined Iron, Ingot Metal and Weld Metal. Alexander Sattmann and Anton Homatsch (C G–Began Jan. 26—1 part to date—30 cts).

MILITARY ENGINEERING.

*18780. Ships of the New British Navy. Ill. William Laird Clowes (E Mag–March.) 3500 w.

†18796. The Future of Maritime Warfare. H. Geffcken (C R–Jan.) 8300 w.

†18839. The French in India. L. B. Bowring (F R–Jan.) 4000 w.

†18867. Charles the Twelfth and the Campaign of 1712-13. Oscar Fredrik, King of Sweden and Norway (N C–Jan.) 9000 w.

*18914. H. M. S. "Resolution." Ill. (E–Jan. 5.) 4800 w.

*18933. War Material. Editorial (Eng L–Jan. 5.) 850 w.

18978. Tactical Instruction of Officers. J. S. Pettit (A & N J–Jan. 20.) 4400 w.

18980. The Bursting of Guns (M N–Jan. 15) 1100 w.

18982. The Modern Naval Status. Editorial (E N–Jan. 28.) 2800 w.

†19159 The International Electrical Congress of 1893, and Its Artillery Lessons. George O. Squier (J U S A–Jan.) 4000 w.

†19160. Artillery, State of New York. H. C. Aspinwall (J U S A–Jan.) 2300 w.

†19161. Siege Artillery. Henry J. Reilly (J U S A–Jan.) 5600 w.

†19162. Vertical Fire. Edmund L. Zalinski (J U S A–Jan.) 1350 w.

†19163. Formulas for Velocity and Pressure in the Bore of a Gun. James M. Ingalls (J U S A–Jan.) 4000 w.

†19164. Artillery Target Practice. G. N. Whistler (J U S A–Jan.) 2800 w.

†19165. Field Artillery Fire. A. D. Schenck (J U S A–Jan.) 4000 w.

†19166. The Importance of Smokeless Powder in War. General Baumgarten (J U S A–Jan.) 4000 w.

†19254. Lincoln's Gettysburg Address. John G. Nicolay (C M–Feb.) 6500 w.

†19255. The Real Stonewall Jackson. D. H. Hill (C M–Feb.) 4500 w.

†19284. My American Experiences. Emil Frey (N A R–Feb.) 4500 w.

†19286. Latest Aspect of the Brazilian Rebellion. Salvador de Mendonca (N A R–Feb.) 4700 w.

19361. The Designing and Building of a War Ship. Ill. W. A. Dobson (Cos–Feb.) 3700 w.

19362. Indian Wars and Warriors. Ill. Elaine Goodale Eastman (Cos–Feb.) 2500 w.

19263. The Meloban and the Pentheroy.—An Episode of Modern Warfare. Ill. James Creedman (Cos–Feb.) 4000 w.

*19423. Competitive Trial of Steel Armor at Texel. Ill. (Eng L–Jan. 19.) 1300 w.

*19424. The Machinery of the United States Navy. Editorial (Eng L–Jan. 19.) 1800 w.

*19462. A Decade of Military and Naval Engineering (E Rev–Jan. 20.) 2700 w.

*19510. The Ram in Action and in Accident (Inv–Jan. 27.) 1800 w.

19557. The United States War Ship "Columbia." Ill. (Sc A S–Feb. 10.) 2500 w.

19574. Speed Premiums for Naval Contracts (E N–Feb. 8.) 1100 w.

19583. The Great Naval Problem. Editorial (Sea–Feb. 8.) 1000 w.

†19600. The Contract Trials of the United States Gunboats Machias and Castine. J. K. Barton and R. G. Denig (J A N E–Nov.) 5800 w.

†19607. The New Spanish Cruiser "Infanta Maria Teresa." (From Engineering.) (J A N E–Nov.) 4000 w.

MINING.

*18778. Florida's Great Phosphate Industry. Ill. Alfred Allen (E Mag-March) 3000 w.

†18786. An Ore-Bucket for Inclined Shafts. Ill. Alexander L. Black (S M Q-Nov.) 600 w.

18793. The Waste of Anthracite. Henry Wurtz (Sc A S-Jan. 13.) 1200 w.

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18858. Bituminous Coal for New England Factories (M G-Jan. 13) 1650 w.

18872. The Year's Mining Product in Colorado (M I T-Jan. 11.) 1500 w.

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*18906. The Courrières Collieries, Pas-de-Calais, France (C G-Jan. 5.) 1200 w.

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*18927. The Sixteen Weeks Coal Stoppage (I S C-Jan. 5.) 2500 w.

*18951. The Western Silver Mine. (Tas.)—New Concentration Plant. W. F. A. Thomae (A M S-Dec. 2.) 2000 w.

*18952. Through the Leigh's Creek Country. —Copper and Gold Mining (A M S-Dec. 9.) 1100 w.

*18954. Mount Lyell Mining and Railway Company. Ill. (A M S-Dec. 16.) 3300 w.

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18997. The Red Point Drift Gravel Mines. (Abstract.) Charles F. Hoffman (M S P-Jan. 13.) 1400 w.

*18999. Accidents in Mines—Carefully Compiled from the Reports of the Pennsylvania Inspectors (C E-Jan.) 2300 w.

*19004. Soldier Run Mine.—The Largest and Best Equipped Mine in the Reynoldsville (Pa.) District. Ill. Fremont M. Brown (C E-Jan.) 4300 w.

19019. The Age of the Iron Ores of East Texas. William Kennedy (Sc-Jan. 12.) 3200 w.

19023. Gold Mining in the South.—The Reasons for Past Failures and for Future Successes. Henry V. Maxwell (M R-Jan. 19.) 1000 w.

19027. Notes on the Alabama Gold Belt (E M J-Jan. 20.) 900 w.

*19046. Notes on Coal Mining. M. E. (C G-Jan. 12.) 1300 w.

*19092. The Production of Gold : Is the Supply Sufficient? J. E. Fraenkel (F-Feb.) 2400 w.

†19172. Phosphatic Deposits in the Trichinopoly District. Ill. H. Wurth (I E-Dec. 23.) 2000 w.

19191. Bauxite Mining. Henry M. Calley (Sc-Jan. 19.) 1500 w.

19192. Notes on the Geology of the Gold Field of Cripple Creek, Colorado. H. L. M'Carn (Sc-Jan. 19.) 5800 w.

19213. The Diamond Prospecting Drill in Mining Canadian Phosphate and Other Irregular Deposits. J. Burley Smith (C Eng-Jan.) 900 w.

19214. Mine Tunnels and Tunnel Timbering. W. A. Carlyle (C Eng-Jan.) 1000 w.

19220. Geological Distribution and Natural Storage of Gas.—From Report of J. D. Weeks (A M & I W-Jan. 19.) 1000 w.

19269. The Ruby. Benjamin F. Mason (Sc A-Feb. 3.) 1800 w.

19299. Manganese in East Tennessee. Henry V. Maxwell (T-Feb. 1.) 1600 w.

19331. Georgia's Gold Fields—Past, Present and Future. J. H. Moore (M R-Feb. 2.) 1000 w.

19338. Mineral Resources of Servia (E M J-Feb. 3.) 950 w.

*19374. Gold Mining in the Colar Field (Min W-Jan. 20.) 4500 w.

*19375. Jay Hawk and Lone Pine Consolidated Mining Company—Limited (Min W-Jan. 20.) 2000 w.

19377. Russia's Petroleum Interests.—Reprint from Pittsburg Gazette (O P D R-Feb 5.) 1500 w.

*19389. Modern Mine Ventilating Plant.—The Walker Patent Indestructible Fan and Engines. Charles H. Higson (I S C-Jan. 19.) 2800 w.

*19399. Hanarte's Improvement in Mine Fans. Ill. (C G-Jan. 19.) 1500 w.

*19400. Safety Clutches for Mine Cages. Ill. J. W. P. (C G-Jan. 19.) 2700 w.

*19402. The Temperatures and Nature of Waters in Deep Collieries. Joseph Libert (C G-Jan. 19.) 1800 w.

19449. Foreign Competition in Oil. W. C. Ford (A G L J-Feb. 5.) 800 w.

*19457. The Gases Enclosed in Coal (E-Jan. 26.) 1000 w.

†19467. The Leasing System in Colorado (Sc Q-Jan.) 3000 w.

†19168. The Importance of Transportation as a Factor in Cheap Mining. Ill. Percy Williams (Sc Q-Jan.) 2500 w.

†19470. General Review of the Michigan Mining Trip. Horace H. Atkins, Jr. (Sc Q-Jan.) 3000 w.

†19471. Notes on Mining in the Lake Superior Region. Ill. J. A. Parra (Sc Q-Jan.) 2800 w.

†19473. Goose Creek and the Gunnison Gold Fields. Ill. Percy Williams (Sc Q-Jan.) 2300 w.

*19481. Electric Conductors for Fiery Mines. Joseph Libert (C G-Jan. 26.) 3100 w.

*19483. The Collieries in India (C G-Jan. 26.) 2500 w.

*19496. The Petroleum Fields of India : Their Present Condition and Their Probable

Future, with Discussion. R. D. Oldham (J S A-Jan. 26.) 8000 w.

*19501. B. Pickard on Work and Wages in the Coal Trade (J G L-Jan. 23.) 1300 w.

19560. The Formenephone for the Musical Analysis of Gases. Ill. (Sc A S-Feb. 10.) 1500 w.

19561. Curious Mineral Formations. Ill. (Sc A S-Feb. 10.) 500 w.

19580. Progress of the Precious Metal Industry in the United States in 1880. S. F. Emmons (M S P-Feb. 3.) 1400 w.

19582. The Era of Nickel Steel. (Extracts.) W. L. Austin (M S P-Feb. 3.) 1250 w.

*19596. Coal Land Development.—Remarks and Suggestions on the Best Method of Opening Up a Coal Mine. M. G. Thomas (C E-Feb.) 1800 w.

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9459. The Manufacture of Coke. Ill. John Fulton (C E-Began Jan., 1893—14 parts to date—30 cts. each).

11282. Mine Ventilation Made Easy. W. Fairley (C E-Began March—12 parts to date—30 cts. each).

11801. Information to Aid in the Search for Gold and Silver. Ill. Arthur C. Lakes (C E-Began April—11 parts to date—30 cts. each).

11804. Fire Damp. H. LeChatelier. Translated by H. H. Stoek (C E-Began April—10 parts to date—30 cts. each).

12450. The Coal Fields of Canada. William Hamilton Merritt (C E-Began May—10 parts to date—30 cts. each).

18222. The Miner and His Perils. Albert Williams, Jr. (Ch-Began Jan.—2 parts to date—30 cts. each).

18580. The Durham Coalfield. M. E. (C G-Began Dec. 22—5 parts to date—30 cts. each).

18640. Hydraulic Mining. Henry Degroot (M S P-Began Dec. 30—6 parts to date—15 cts. each).

18835. The Missouri Mineral Exhibit at the World's Columbian Exposition. E. O. Hovey (E M J-Began Jan. 13—Ended Jan. 20—2 parts—15 cts. each).

18904. Mine Ventilation. M. G. Hanarte (C G-Began Jan. 5—Ended Jan. 12—2 parts—30 cts. each).

19007. How Distances Are Measured in Underground Work. Otto C. Burkhart (C E-Began Jan.—1 part to date—30 cts).

19008. Examining and Sampling Mining Properties. Ill. A. C. Lakes (C E-Began Jan.—1 part to date—30 cts).

19079. Talks on Quarrying. Edward H. Williams, Jr. (S-Began Jan.—1 part to date—30 cts).

19141. The Silver Mines of Colquechaca, Bolivia. Robert Peele, Jr. (E M J-Began Jan. 27—Ended Feb. 3—2 parts—15 cts. each.)

19230. Geological Distribution of Gold and Silver in the United States. S. F. Emmons (Min R-Began Jan. 25—Ended Feb. 1—2 parts—15 cts. each).

19337. Notes on Arizona Mines. Theodore B. Comstock (E M J-Began Feb. 3—1 part to date—15 cts).

19595. Examining Placers. A. C. Lakes (C E-Began Feb.—1 part to date—30 cts).

RAILROADING.

*18776. A Plea for Series Electric Traction. Nelson W. Perry (E Mag-March) 3500 w.

*18779. The Tehuantepec Isthmus Railway. Don Senor Matias Romero (E Mag-March) 4000 w.

18809. Railroad Extension in England. W. M. Acworth (R G-Jan. 12.) 1500 w.

18810. Train Loadings for Railroad Bridges. (Extracts.) Theodore Cooper (R G-Jan. 12.) 2300 w.

18811. Rapid Transit in Chicago (R G-Jan. 12.) 1500 w.

18812. Uniform Classification of Freight. Editorial (R G-Jan. 12.) 2000 w.

18831. Bridge and Building Department. Rules of a Railroad (E R-Jan. 13.) 3000 w.

18841. Elevated Electric Railway Agitation in Chicago (W E-Jan. 13.) 2200 w.

†18843. The Practicability of Electric Conduit Railways, with Discussion. Ill. Albert Stetson (T A I E E-Dec.) 9000 w.

18859. The Interstate Commerce Law and Railway Receiverships. Editorial (R A-Jan. 12.) 900 w.

18861. Recommendations of New York Railroad Commissioners.—Abstract of report (S R G-Jan. 13.) 1350 w.

18868. The Classification of Freight.—Abstract from Report of Interstate Commerce Commission, with Editorial (R R-Jan. 13.) 3500 w.

18869. The Purpose and Scope of Railway Regulation.—Abstract from Report of Interstate Commerce Commission (R R-Jan. 13.) 3000 w.

18886. The Line Repairer. Julian A. Moses (E R N Y-Jan. 17.) 1900 w.

*18890. Air Resistance. A. Bowman (R P L-Jan. 1.) 1200 w.

*18941. High Speed Electric Railways. Frank B. Lea (E E L-Jan. 5.) 1000 w.

*18967. A Street Car Curiosity. Ill. (S R R-Jan.) 400 w.

*18969. The Mousam River Railroad. Ill. (S R R-Jan.) 1100 w.

*18970. The Placing of Car Trucks for Rounding Curves. Ill. Emil Ehubom (S R R-Jan.) 700 w.

*18972. T-Rails for Street Railway Use. Ill. John A. Beeler (S R R-Jan.) 700 w.

18983. The Train Staff System and the Electro-Pneumatic Locking Plant. Ill. (E N-Jan. 18.) 1800 w.

18987. A Useful Device for Electric Railway Stations. J. C. Lincoln (S M-Jan. 15.) 1000 w.

18989. A Simple Method of Lowering a Bridge.—N. Y., N. H., and H. R. R. (R G–January 19.) 450 w.

18990. Railroad Building with Reference to Economy in Operating. (Extracts.) C. Frank Allen (R G–Jan. 19.) 5000 w.

18991. Jewett's Patent Composite Car Framing. Ill. (R G–Jan. 19.) 750 w.

18993. The Railroad Rate Question in England. W. M. Acworth (R G–Jan. 19.) 1650 w.

18994. Brass and Copper Tubes for Locomotive Boilers (R G–Jan. 19) 1350 w.

*19050. The Railways of New York.—Past and Present Methods of Transport (Tr–Jan 12.) 2400 w.

19063. Use of Private Cars.—From Report of Interstate Commerce Commission (R R–Jan. 20.) 2000 w.

19064. The Anglo-Chilian Nitrate Railway, Tocopilla to Toco. Ill. (R R–Jan. 20.) 2200 w.

19065. The Kinetic Motive Power System for Street Railways. A. P. Dodge (S R G–Jan. 20.) 650 w.

19072. Essential Station Instruments. D. C. Jackson (E R N Y–Jan. 24.) 1900 w.

19109. Some Notable Locomotives. Ill. (Sc A–Jan. 27.) 750 w.

19110. Electric Welding of Rails in Place. Ill. (Sc A–Jan. 27.) 1900 w.

†19124. The New Railway Station at Dresden. Ill. C. Köpcke (T C E–Nov.) 2000 w.

19130. The Hobb's Island Ferry Transfer. Ill. (R G–Jan. 26.) 1600 w.

19133. New York Central Railroad Track Through Paved Streets. Ill. (E N–Jan. 25.) 450 w.

19176. Pools and Railway Receiverships. Editorial (R A–Jan. 26.) 1350 w.

19177 The Cause of Railway Insolvencies. Editorial (R A–Jan. 26) 1300 w.

19178. The Bellefontaine Bridge. Ill. (R A–Jan. 26.) 700 w.

19185. Four Cylinder Compound Locomotives of the Paris, Lyons and Mediterranean Railway, France. Ill. (R R–Jan. 27.) 1500 w.

19186. Causes of Railway Embarrassment. Articles from Chicago Tribune, by E. St. John and E. P. Ripley, with Editorial (R R–Jan. 27.) 3400 w.

19188. The Soulerin Air Brakes. Ill. (R R–Jan. 27.) 1000 w.

19190. Movable Sidewalk for Chicago Streets (S R G–Jan. 27.) 3500 w.

*19203. A Rate War Between Government Railways. (E–Jan. 12.) 2100 w.

19239. Storage Battery Traction at Washington, D. C. Ill. George C. Maynard (E R N Y–Jan. 31.) 2500 w.

*19247. Discipline Without Punishment. George R. Brown (L E–Feb.) 4500 w.

*19248. Sight Feed Lubricators. Ill. (L E–Feb.) 2800 w.

*19249. Development of the American Car (L E–Feb.) 1400 w.

*19256. Passenger Car Construction. Ill. Ernest Merrick (N C B–Feb.) 4500 w.

19268. An Electric Mountain Railway.—Mount Lowe, Southern California. Ill. (Sc A–Feb. 3.) 1000 w.

*19293. Compound Mogul Freight Engine Built by the Pittsburg Locomotive Works. Ill. (A E R J–Feb.) 500 w.

*19294. Comparison of English and American Locomotives in the Argentine Republic (A E R J–Feb.) 2500 w.

*19296. Metal Under Frames for Freight Cars. Ill. G. R. Jonghins (A E R J–Feb.) 5900 w.

19310. The Effect of Dirt in Air Brake Pipes (E N–Feb. 1.) 1000 w.

19311. Rack Tests of Air-Brakes by M. C. B. Committee (E N–Feb.) 1400 w.

19312. Coaling Station of the Manhattan Elevated. Ill. (R G–Feb. 2.) 1200 w.

19313. Improvements in Permanent Way and the Needs and Possibilities of Better Rail Fastenings. Ill. Walter Katte (R G–Feb. 2.) 3500 w.

19314. Railroad Property Records. Robert A. Cummings (R G–Feb. 2.) 2000 w.

19315. Cable vs. Electric Motive Power for Street Railroads (R G–Feb. 2.) 2100 w.

†19339. The Government Tramways of New South Wales. Ill. George Macoun (S R J–Feb.) 4000 w.

†19341. An Investigation of an Egyptian Franchise. Arthur Hodges (S R J–Feb.) 1500 w.

†19343. The Early Pioneers of the Electric Railway. Ill. (S R J–Feb.) 4200 w.

*19357. Decline in Railway Values (S Ec–Feb.) 1000 w.

†19365. Recent Railroad Disasters. La Fayette C. Loomis (P S M–Jan.) 2400 w.

*19417. Economy in Street Railroad Management. Foree Bain (S R E N–Jan.) 1100 w.

*19418. Cleaning of Tramway and Other Rails. (Abstract.) H. Conradi (S R E N–Jan.) 1000 w.

*19426. Location Surveys for Railways (Eng L–Jan. 19) 1200 w.

*19497. The Modern Railway Educator (Tr–Jan. 26.) 2200 w.

*19500. Gas Engines for Driving Tramcars (J G L–Jan. 23.) 2500 w.

*19504. The Hanover Electric Tramways. Ill. (R W–Jan.) 1600 w.

*19506. Railway Station Lighting.—The St. Lazare (Paris), and the Liverpool Street (London) Termini. Ill. (R W–Jan.) 2700 w.

*19507. The Route to the Riviera. Ill. (R W–Jan.) 1200 w.

*19509. The Horse in Tramway Service. J. Forest Brunton (R W–Jan.) 1000 w.

*19516. Self-Acting Long-Span Wire Ropeway at Pinesolo. Ill. (Eng L–Jan. 26.) 1000 w.

*19523. Tunnels on the Dore and Chinley Railway (I C T–Jan. 26.) 1800 w.

19526. Needs of Street Railways.—Opinions of Managers and Engineers Concerning the Improvements of 1893 and the Outlook for the Immediate Future (S R G-Feb. 3.) 3700 w.

19528. Storage Battery Traction at Washington, D. C.—A Reply to Mr. Maynard. William Bracken (E R N Y-Feb. 7.) 800 w.

19537. From Strawberries to Snow by the Mount Lowe Electric Road. Ill. (E E N Y-Feb. 7.) 1800 w.

19555. A Projected Tubular Railway between Calais and Dover (Sc A-Feb. 10.) 1200 w.

19559. New Electric Tramway Car. Ill. (Sc-A S-Feb. 10.) 1600 w.

19566. The Illinois Central Shops at Burnside. Ill. (R G-Feb. 9.) 1300 w.

19567. The Wengern Alp Rack Railroad, Switzerland. Ill. T. Delmar (R G-Feb. 9.) 2600 w.

19568. Air Brakes and and Their Maintenance. (Abstract.) G. W. Rhodes (R G-Feb. 9.) 2800 w.

19569. Train Accidents in 1893 (R G-Feb. 9.) 1200 w.

19573. The Last Rapid Transit Proposition for New York (E N-Feb. 8.) 1500 w.

Serials.

9254. Railway Management. Horace Cope (R R-Began Dec. 1892—9 parts to date—15 cts. each).

12001. Rails on the Creep. Ill. A. Ewbank (I E-Began March 11—38 parts to date—45 cts. each).

15496. Railroad Coppersmithing. John Fuller, Sr. (L E-Began Sept.—6 parts to date—30 cts. each).

17826. The Evolution of the Railway Brake. Ill. Paul Synnesvedt (R E M-Began Dec. —3 parts to date—15 cts. each).

18225. Experiences of a Superintendent. C. P. Young (S R R-Began Dec.—2 parts to date—30 cts. each).

18549. The Intrinsic value of Street Railway Investments. Edward E. Higgins (S R J-Began Jan.—2 parts to date—45 cts. each).

18566. The Railway Rates Committee's Report (Tr-Began Dec. 22—3 parts to date—30 cts. each).

18619. Pioneer Light Railways for India. Everard Calthrop (R W-Began Dec.—2 parts to date—30 cts. each).

18711. Electric Railway Motors: Their Construction and Operation. Nelson W. Perry (S R G-Began Jan. 6—5 parts to date—15 cts. each).

18891. The Railway Mania. G. A. Sekon (R P L-Began Jan. 1—1 part to date—30 cts).

18911. More Light on Electric Traction. L. Epstein (E R L-Began Jan. 5—Ended Jan. 13—2 parts—30 cts. each).

18957. Ventilation of Passenger Cars. James F. Hobart (R C J-Began Jan.—1 part to date—15 cts).

18968. Moving Houses Over Railway Tracks (S R R-Began Jan.—1 part to date—30 cts).

19062. Locomotive Cyltnder and Frame Fastenings Ill. (R R-Began Jan. 20—Ended Jan. 27—2 parts—15 cts. each).

19197. Guide Bearings for Railway Rod-Connections. Ill. (E-Began Jan 12—Ended Jan. 19—2 parts—30 cts. each).

19251. Around the World to China and Home. Ill. E. J. Lewis (L E-Began Feb.—1 part to date—30 cts).

19306. The Third Avenue Cable Railway, New York City. Ill. (E N-Began Feb 1—1 part to date—15 cts).

19340. The Transformation of Baltimore. Ill. (S R J-Began Feb.—1 part to date—45 cts).

19505. Notes on Some French and Italian Railways. J. Pearson Pattinson (R W-Began Jan.—1 part to date—30 cts).

19527. Electrolytic Effects in Street Railway Return Circuits; Their Cause and Prevention. W. Nelson Smith (S R G-Began Feb. 3—1 part to date—15 cts).

SANITARY ENGINEERING.

18832. Sewage Disposal at Worcester, Mass. Ill. (E R-Jan. 13.) 4400 w.

18834. Ventilation of the New Netherland Hotel. Ill. (E R-Jan. 13.) 900 w.

†18864. Sanitary Insurance; A Scheme. G. Walter Steeves (N C-Jan.) 5500 w.

*18937. Sanitary Engineering. Editorial (Eng L-Jan. 5.) 1200 w.

*18938. Water Supply. Editorial (Eng L-Jan. 5.) 1300 w.

†19117. Some Questions Concerning the Filtration of Water. W. Kümmel (T C E-Nov.) 2000 w.

†19119. Purification of Sewage and of Water by Filtration. Hiram F. Mills (T C E-Nov.) 6000 w.

†19120. The Sewage System of Milwaukee and the Milwaukee River Flushing Works. Ill. G. H. Benzenberg (T C E-Nov.) 5600 w.

19153. Sewage Filtration with Special Aeration (E R-Jan. 27.) 1200 w.

19229. Kansas City Sewerage. Ill. (F W-Jan. 20.) 700 w.

19330. Ventilation and Warming of the New High School, Montclair, N. J. Ill. (E R-Feb. 3.) 1350 w.

*19360. Unhealthfulness of Illuminating Gas. J. S. Leonhardt (A H-Feb.) 900 w.

*19422. Glasgow Sewage Disposal Works. Ill. (Eng L-Jan. 19.) 3200 w.

19553. A New Sanitary Building (Sc A-Feb. 10.) 1500 w.

19572. The Tiber Creek Sewer Flush Gates, Washington, D. C. (E N-Feb. 8.) 700 w.

Serials.

5358. Sewage Purification in America. Ill. (E N-Began July 14, 1892—38 parts to date—15 cts. each).

10425. A Healthy Home. Francis Vacher (S R-Began Feb. 1, 1893—24 parts to date—30 cts. each).

14839. Water Purification in America (E N-Began Aug. 3—7 parts to date—15 cts. each).

15132. A Review of Recent Plumbing Practice. G. Brown (N B-Began Aug.—4 parts to date—30 cts. each).

18870. Humidity and Ventilation. Joseph Masinette (A Ar-Began Jan. 13—1 part to date—15 cts).

19132. The Metropolitan Sewerage Systems of Massachusetts. Ill. (E N-Began Jan. 25—2 parts to date—15 cts. each).

STEAM ENGINEERING.

18814. Perfect Combustion by the Use of the Gadey Air-Grates. Ill. H. M. Underwood. (M R-Jan. 12.) 1500 w.

18828. Uninsured Boilers in Massachusetts.—The Result of the Inquiry into Their Condition (B J C-Jan. 13) 4600 w.

*18892. Making a Lancashire Boiler. James Shenton (P Eng-Jan. 5.) 4800 w.

*18924. The Principles of Action of the Axial Steam Turbine. Ill. W. H. B. (E L-Jan. 5.) 1100 w.

18998. Some Experiments on the Effect of Water Hammer. R. C. Carpenter and S. H. Barraclough (S V-Jan. 15.) 1600 w.

19030 Ins and Outs of the Blower System. Walter B. Snow (Met W-Jan. 20.) 3700 w.

*19033. An Engine Building Record for 1893 (El-Jan. 12.) 1200 w.

*19053. Small Steam Carriages for Common Roads. Ill. William Fletcher (P Eng-Jan 12.) 2300 w.

19106. Throttling vs. Automatic Cut-off Engines (A M-Jan. 25.) 1000 w.

19146. About Boilers.—The Combustion of Coal (B J C-Jan. 27.) 2200 w.

*19174. Boiler Explosions.—Their Causes and Their Prevention Explained. Ill. (M-Jan. 15.) 5300 w.

19193. Some Poor Boilers and Engineers (B J C-Jan. 20.) 3000 w.

19194. About Chimneys.—Points to Remember in Designing One (B J C-Jan. 20.) 1800 w.

19196. The Value of a Proper Air Supply in Burning Coal (B J C-Jan. 20.) 850 w.

19332. About Boilers.—The Proper Method of Setting (B J C-Feb. 3.) 2000 w.

19333. Recent Development in Stationary Engines (B J C-Feb. 3.) 2500 w.

19334. Throttle Governors vs. Automatic Cut-off (B J C-Feb. 3.) 900 w.

†19604. Parson's Steam Turbine. (Abridged from Engineering.) Ill. (J A N E-Nov.) 8000 w.

†19609. A Simple Graphic Method of Considering the Obliquity of Connecting Rods in Valve Diagrams. Ill. Albert E. Guy (J A N E-Nov.) 2000 w.

Serials.

16655. The Steam Pump (T-Began Oct. 15—6 parts to date—15 cts. each).

16756. Theory of Steam Engine Governors. J. Begtrup (A M-Began Oct. 19—3 parts to date—15 cts. each).

17292. On the Working of Steam Pumps on the Russian South-Western Railways (M W-Began Nov. 3—Ended Jan. 12—4 parts—30 cts. each).

17823. Designing Corliss Gears. Ill. James Dunlop (P Eng-Began Nov. 24—5 parts to date—30 cts. each).

18372. The Steam Engine Indicator. Ill. Jerdan Nichols (M W-Began Dec. 15—Ended Jan. 19—5 parts—30 cts. each).

18986. Boiler Calculations. James F. Hobart (S M-Began Jan. 15—2 parts to date—15 cts. each).

19042. Water-Tube Boilers (Eng L-Began Jan. 12—3 parts to date—30 cts. each).

TELEPHONY AND TELEGRAPHY.

*18777. The Proposed Cables Under the Pacific. Herbert Laws Webb (E Mag-March) 3000 w.

18790. Another Boston Telephone. Ill. (E N Y-Jan. 10.) 1000 w.

*18940. On Certain Devices to Utilize Inductive Action in the Construction of Long Submarine Cables. Desmond G. Fitzgerald (E E L-Jan. 5.) 700 w.

*19034. Telegraph Statistics and Editorial (El-Jan. 12.) 1800 w.

19083. Self-Induction and Bi-Metalic Telephone Wires. A. N. Mansfield (E E N Y-Jan. 24.) 700 w.

19101. Non-Infringing Telephone Transmitters. William A. Rosenbaum (E W-Jan. 27.) 750 w.

19112. The Telephone Situation. Nelson W. Perry (E N Y-Jan. 24.) 2500 w.

19233. Bi-metallic Telephonic Conductors and Their Relation to Resonance on Long Distance Circuits. F. W. Dunbar (E E N Y-Jan. 31.) 2300. w.

19266. All May Have Telephones. Ill. (Sc A-Feb. 3.) 1100 w.

*19347. Some Data on Cables for the Pacific. William J. Hancock (E L-Jan. 19.) 900 w.

*19349. Sloper's Patent Interchangeable Telephone System. Ill. (E L-Jan. 19.) 800 w.

19427. The Brooklyn Police Patrol Telegraph System. Ill. (E A-Feb. 3.) 900 w.

19527. A Large Telephone Submarine Cable Successfully Laid. Ill. (E R N Y-Feb. 7.) 650 w.

19530. A History of the Telephone. Ill. W. Clyde Jones (E R N Y-Feb. 7.) 2700 w.

Serials.

18086. The Limitations to Long Distance Telephony. F. W. Dunbar (E E N Y-Began Dec. 13—4 parts to date—15 cts. each).

18628. The Electro-Magnet; or Joseph

Henry's Place in the History of the Electro-Magnetic Telegraph. Ill. Mary A. Henry (E E N Y–Began Jan. 3—5 parts to date—15 cts. each).

18876. The Telephone Patent Situation (E E N Y–Began Jan. 17—4 parts to date—15 cts. each).

19016. Is Telephonic Induction Electrostatic or Electromagnetic? Ill. F. W. Dunbar (E W–Began Jan. 20—2 parts to date—15 cts. each).

MISCELLANEOUS.

†18281. Recent Experience on the U. S. Coast and Geodetic Survey in the Use of Long Steel Tapes for Measuring Base Lines. Ill. R. S. Woodward (T C E–Oct.) 6800 w.

†18283. Fundamental Units of Measure. T. C. Mendenhall (T C E–Oct.) 4800 w.

†18284. Historical Notes upon Ancient and Modern Surveying and Surveying Instrumeuts. Ill. H. D. Haskold (T C E–Oct.) 6500 w.

*18293. Cleopatra's Needle and Its Preservation. Ill. N. Restorff (S–Dec.) 2200 w.

*18317. British Commercial Interests in Morocco (Tr–Dec. 15.) 1500 w.

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†18330. The City and State of Pará, Brazil (I R W–Dec. 15.) 1800 w.

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†18334. Indian Currency. Guilford L. Molesworth (An A A–Jan.) 11200 w.

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†18337. The Political Ethics of Herbert Spencer. Lester F. Ward (An A A–Jan.) 13000 w.

†18338. La Science Sociale. Paul de Rousiers (An A A–Jan.) 10000 w.

*18373. Experiments on Flying. Ill. C. Runge (N–Dec. 14.) 900 w.

*18382. The Training of an Engineer. C. H. Scott (I C B–Dec. 15.) 1650 w.

18411. The Records of Rensselaer Graduates (E N–Dec. 21.) 2200 w.

18425. Control of Fires. Ill. John R. Murphy (F W–Dec. 30.) 4500 w.

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18462. The Organization of the City Engineer's Office. Albert F. Noyes (E R–Dec. 30.) 2700 w.

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18501. The Equipment of Engineering Schools. Robert H. Thurston (Sc A S–Dec. 30.) 4000 w.

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*18530. Aerial Flight. Sidney H. Hollands (P Eng–Dec. 22.) 2500 w.

*18572. Dangerous Occupations. Editorial (E–Dec. 22.) 2800 w.

*18581. Engineers of To-Day—and Yesterday. James Nicholas Douglass (E Rev–Dec. 20.) 3000 w.

*18587. The Mission and Destiny of Canada W. T. Stead (R of R–Jan.) 5000 w.

†18588. Geology of the Waterloo Quartzite Area. Descriptive of the Exposures, Structural Features, Prevailing Characters, etc. Ill. Ira M. Buell (T W A–Vol IX–Part II.) 6000 w.

†18589. The Structure and Affinities of Bunops Scutifrous Birge. Harriet Bell Merrill (T W A–Vol IX–Part II.) 6000 w.

†18590. The Income Tax and Corporations. William T. Wilson (N A R–Jan.) 2700 w.

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*18716. The Sonnblick Mountain Observatory. Ill. (N–Dec. 28.) 1100 w.

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*18748. The Rating of Building Land in London (A L–Dec. 29.) 2100 w.

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18789. Technical Education in Europe and America. Silvanus Thomson (E N Y–Jan. 10.) 1700 w.

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†18799. The Rise and Development of Anarchism. Karl Blind (C R–Jan.) 6500 w.

*18803. Dedecoration (Pl D–Jan. 1.) 900 w.

18815. Mineral Wool.—What It Is and Its Uses (M R–Jan. 12.) 1000 w.

18818. The Greater New York. Editorial (E N–Jan. 11,) 1200 w.

18819. The Demand for Mining and Other Engineers (E N–Jan 11.) 1600 w.

18824. The Empire State's Canals. (Ex.

tracts.) Ill. R. P. Flower (Sea-Jan. 11.) 1900 w.

†18862. Professor Tyndall T. H. Huxley (N C-Jan.) 5800 w.

†18865. The Scramble for Gold. I. Julius Vogel. II. J. P. Heseltine (N C-Jan) 4000 w.

†18866. Recent Science. Prince Kropotkin (N C-Jan.) 7200 w.

*18915. The Manchester Ship Canal. Editorial (E-Jan. 5) 1800 w.

*18918. German Painting. Ill. Frederick Leighton (A L-Jan. 5.) 2500 w.

*18945. Patents. W. Griffith (E P-Jan. 1.) 2000 w.

†18946. A New Imperial Highway. J. F. Hogan (W R-Jan.) 3800 w.

†18948. American Taxation and Politics. Edward J. Shriver (W R-Jan.) 3600 w.

*18977. Lieutenant Peary's Expedition. Cyrus C. Adams (Ch-Feb.) 2600 w.

*18979. French Engineers and American Engineering. (Abstract.) G. Richard (S J E-Jan.) 900 w.

18988. The Influence of Technical Literature upon the Life of a Young Mechanic. A. S. Mallory (S M-Jan. 15.) 1100 w.

*19000. The Effect of Various Gases on Animal Life. J. R. Wilson (C E-Jan.) 2800 w.

*19045. Industrial Occupations. Editorial (Eng L-Jan. 12.) 2500 w.

19059. Economics of Manufacture. B. F. Spalding (A S-Jan. 20.) 2400 w.

*19088. A Review of the Hawaiian Controversy. James Schouler (F-Feb.) 8000 w.

*19089. The Nicaragua Canal—Ours or England's? Courtenay DeKalb (F-Feb.) 2300 w.

*19090. The Wilson Tariff for a Deficit Only. Albert Clarke (F-Feb.) 2600 w.

*19091. The Gold Basis Fixed by Commerce Itself. Edward Atkinson (F-Feb.) 600 w.

*19139. The Historical Aspect of the Currency. W. Alison (A P R-Dec. 15.) 3600 w.

19148. The South's Great Staple—Cotton. Richard H. Edmonds (M R-Jan. 26.) 3000 w.

†19181. On the Geological Position of Bennettites Dacotensis MacBride, with Remarks on the Stratigraphy of the Region in which the Species Was Discovered. Samuel Colvin (A G-Feb.) 2000 w.

†19182. Interglacial Fossils from the Don Valley, Toronto. A. P. Coleman (A G-Feb.) 3400 w.

†19183. On the Value of Supposed Algæ as Geological Guides, Joseph F. James (A G Feb.) 2300 w.

†19184. A Revised Classification of the Spire-Bearing Brachiopoda. Charles Schuchert (A G-Feb.) 1800 w.

†19253. Lincoln's Place in History. Ill. John Coleman Adams (C M-Feb.) 6000 w.

19272. Professor Wellner's Flying Machine. Ill. (Sc A S-Feb. 3.) 1000 w.

19273. Some of the Ancient Uses of Asphaltum by the Aborigines of California. Ill. (Sc A S-Feb. 3.) 700 w.

19274. The Refining of Petroleum Oil. Ill. (Sc A S-Feb. 3.) 1600 w.

†19285. The Income Tax in England. John Lubbock (N A R-Feb.) 2700 w.

†19288. Are We a Plutocracy? W. D. Howells (N A R-Feb.) 4800 w.

†19289. Needed Municipal Reform. I. Our Present Opportunity. C. H. Parkhurst. II. Juggling with the Ballot. John W. Goff (N A R-Feb) 6000 w.

*19358. Colorado's Mistake About Silver. (S Ec-Feb.) 1000 w.

19364. Gliding Flight. Ill. L. P. Mouillard (Cos-Feb.) 4000 w.

†19369. Inventions and Industry at the South. Barton H. Wise (P S M-Jan.) 6000 w.

†19372. Tyndall and His American Visit. E. A. Youmans (P S M-Feb.) 6000 w.

*19380. Technical Education (E-Jan. 19.) 2500 w.

19391. What Large Salaries Are Paid for. Editorial (R E M-Feb.) 1000 w.

*19408. The Taxation of Ground Values (B A-Jan. 19.) 1800 w.

*19432. Feats of Modern Engineering. (Abstract.) Henry Ward (I C B-Jan. 19.) 700 w.

*19439. The Age of Exhibitions and Some of Its Teachings (Inv-Jan. 20.) 1800 w.

*19441. Parallel Motions.—The Pantograph. A. MacLay (P Eng-Jan 19.) 1500 w.

Serials.

14653. Theory vs. Practice. W. M. Patton (S-Began July—7 parts to date—30 cts. each).

16290. The Atmosphere as a Medium of Travel. Ill. Fred W. Breary (I & I-Began Sept. 15—8 parts to date—30 cts. each).

16514. The Evolution of Artificial Light. E. L. Lomax (P A-Oct. 16—7 parts to date—15 cts. each).

17553. Management of Men and Manufacturing Industries. Thomas D. West (Ir Age—Began Nov. 23—5 parts to date—15 cts. each).

17842. Great Works and Their Founders. Ill. (E Rev-Began Nov. 20—2 parts to date—30 cts. each).

18402. The Development and Extent of the Fertilizer Industry. Charles W. Shepard (O P D R-Began Jan. 1—Ended Jan. 22—3 parts—15 cts. each).

18912. Engineering Cost Accounts (E-Began Jan. 5—2 parts to date—30 cts. each).

18930. Carnot and Modern Heat. Oliver Lodge (Eng L-Began Jan. 5—4 parts to date—30 cts. each).

19052. Notes on the Manufacture of Ropes. W. C. Popplewell (P Eng-Began Jan. 12—2 parts to date—30 cts. each).

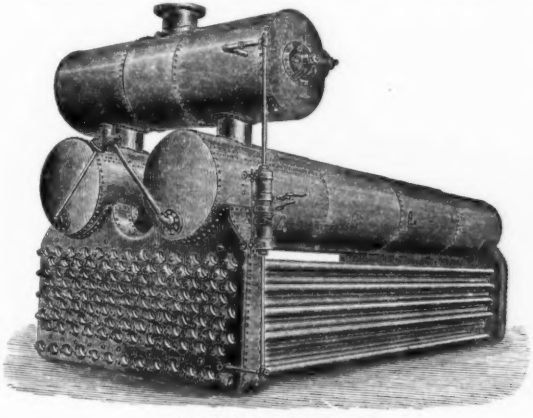
19460. The Rise and Progress of Technical Societies (E Rev-Began Jan. 20—1 part to date—30 cts).

IMPROVED MACHINERY

The matter published in this department is not paid for, nor can it be classed as advertisin But as the information is necessarily obtained from those who offer the appliances for sale, it is proper to say that the manufacturers, rather than ourselves, are responsible for the statements made.

The Heine Safety-Boiler.

THIS boiler is composed of the best lap-welded wrought-iron tubes, extending between and connecting the inside faces of two water-legs, which form the end connections between these tubes and a combined steam and water drum or "shell," placed above and parallel with them. These end chambers are composed each of a head-plate and a tube-sheet flanged all around and joined at the bottom and sides by a butt strap of the same material. The water-legs, stayed by hollow-stay bolts of hydraulic tubing, form the strongest parts of the boiler and its natural support. The shells are cylinders with heads dished to form parts



THE HEINE SAFETY-BOILER.

of a true sphere. Both the cylinder and its spherical heads are free, therefore, to follow their natural lines of expansion when put under pressure. The construction of the boiler is such that the height of the steam space in front is about two-thirds the diameter of the shell, while at the rear the water occupies two-thirds of the shell, the whole contents of the drum being divided equally between steam and water.

In operation, the boiler being filled to middle water line, the fire is started on the grate. The flame and gases pass over the bridge wall and under the lower tier of tiling, finding in the ample combustion-chamber space, temperature, and air-supply for complete combustion before bringing the heat in contact with the main body of the tubes. Then, when at its best, it rises through the spaces between the rear ends of the tubes, between the rear water-leg, and the back end of tiling, and is allowed to expend itself on the entire grooved heating surface without meeting any obstruction. Ample space makes leisurely progress for the flames, which meet in turn all the tubes, lap round them, and finally reach the second uptake at the forward end of the top tier of tiling, with their temperature reduced to less than 900° F. This has been measured here, while wrought iron would melt just above the lower tubes at the rear end, showing a reduction of temperature of over 1800° F. between the two points. As this space is studded with water-tubes, swept clean by a positive and rapid circulation, the absorption of this great amount of heat is explained. The gases next travel under the bottom and sides of the shell and reach the uptake at just the proper temperature to produce the draft required. This varies of course according to chimney, fuel, duty required, etc. With boilers running at their rated capacity, 450 F.° is seldom exceeded. Meanwhile, as soon as the heat strikes the tubes, the circulation of the water begins. The water nearest the surface of the tubes becoming warmer, rises, and as the tubes are higher in front, this water flows towards the front water-leg, where it rises into the shell, while colder water from the shell falls down the rear water-leg to replace that flowing forward and upward through the tubes.

The essential merit of this boiler is in the

remarkably high efficiency of its heating surface. It is this efficiency which enables the manufacturers—or rather *forces* them—to allow a smaller number of square feet of heating surface per horse-power (in order to give the boiler a rating at its most economical point of working) than many of their competitors are *obliged* to allow. While practically all of their water-tube competitors regularly allow 11 to 11.5 square feet of heating surface per horse-power, the Heine boiler allowance upon a similar basis of rating horse-power is about 9 square feet. *Above* or *below* the rating which is given to this boiler the economy of operation begins gradually to decrease, and a Heine boiler rated on 11.5 square feet would be a mis-rated boiler, just as others would be if rated on 9 square feet. To illustrate, in all the cases the nominal rating of the several types of boilers is, or should be, at approximately the point of most economical working. A Heine boiler rated at 250 horse-power, when rated upon a basis of 11.5 square feet per horse-power, would become slightly less than 200 horse-power. Buyers usually select a boiler somewhat larger than their actual necessities. In most cases, therefore, such a boiler would be called upon to do something like 175 horse-power of actual work. Now this boiler has been shown, by innumerable experiments, to work most efficiently at 250 to 300 horse-power, and if the boiler were running at 175 horse-power the same economy could not be guaranteed as if the boiler were in operation at its proper rating of 250 horse-power. There are indications that the steam-engineering world is gradually coming to see this question of heating surface in its true light, and to realize that *efficiency* of heating surface and not mere *quantity* is the thing to consider.

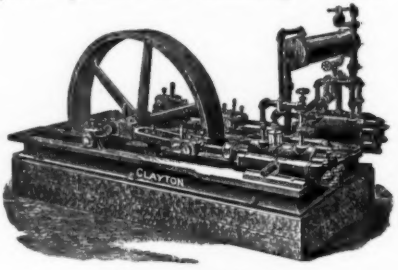
The manufacturers are the Heine Safety Boiler Co., No. 421 Olive street, St. Louis, Mo.

A New Air-Compressor.

THE Clayton Air-Compressor Works, at that time builders of steam-pumps and general mining-machinery, in 1871 introduced the first Clayton air-compressor, and recorded a marked advance over contemporary types. The rapidly-broadening field of usefulness for compressed air created an ever-growing demand for high-class air-compressing machinery, and soon caused the Clayton Works to discontinue all other lines and concentrate the entire capacity of their plant upon the construction of air-compressors. Since thas time they have made this type of machinery their specialty, laboring constantly to attain a higher plane of general excellence and adopting every improvement that would raise the standard of their machines.

Among the numerous special designs which they are continually placing upon the market is a Compound Belt Actuated Air Compressor, which is illustrated herewith. This compressor is intended for experimental and other duties in which air is used under pressures as high as 500 pounds per square inch, where it is preferred to operate the compressor by belt-power.

Two parallel cylinders are employed, as shown, as in a regular pattern of duplex compressor, one cylinder compressing the air to 80 pounds pressure and transmitting it thence



A NEW AIR-COMPRESSOR.

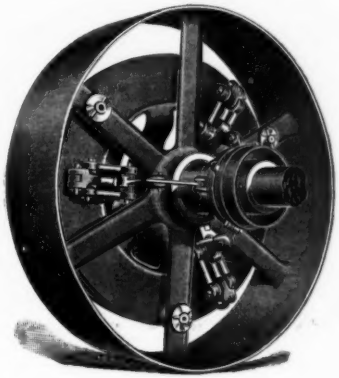
through the cooler shown above the cylinders to the second, or high-pressure, cylinder, which completes the compression. The cooling apparatus combines the most efficient devices known for extracting the heat of compression from the air in transit, and the cylinders are surrounded with the latest improved water-jackets for absorbing the heat of compression by an external circulation of water around the cylinders. The suction-valves are of the poppet style, and are designed especially for durability and tightness under high duty; they are equipped with the Clayton patent safety stems, absolutely avoiding the possibility of a valve falling into the cylinder and reducing clearance space to a minimum by permitting the pistons to run close up to the cylinder-heads. As an extra precaution, the main valve-stems are fitted with both flange-nuts and jam-nuts. The pistons consist of a series of metallic rings of a composition made especially for the requirements of the duty. The connecting-rods, bearings, etc., are all in accordance with the latest steam-engine practice, and the entire machine is a fitting representation of the continued progress of a house distinguished for excellence in its line. A similar design of steam-actuated compressor is constructed for operation by direct steam connection.

An Improved Friction-Clutch Pulley.

THE pulley illustrated in the accompanying engraving has a novel form of construction, designed to secure increased efficiency, durability, ease of adjustment, and quickness of repair, overcoming the only valid objection heretofore urged against friction-clutch pulleys in general. The clutch mechanism of the "Imperial" pulley may be described briefly as follows:

The pulley is provided with two circular friction rings, between which is a friction disk. The friction disk is keyed to the shaft and turns with it, while the balance of the mechanism and pulley is loose on the shaft. The clutch levers clamp the friction disk between the friction rings, thereby setting the pulley in motion. The clutch mechanism is very positive and quick-acting, giving immediate control over the pulley.

The friction surfaces of the friction rings are protected by strips of insulated fiber, affording extra precaution against wear. These strips can



IMPERIAL FRICTION CLUTCH-PULLEY.

be replaced at any time. The bushings are made in halves, and are renewable. They are babbitted, and can be removed and rebabbtited at any time without taking the pulley from the shaft. As the friction surfaces and bushings are the parts subject to greatest wear, the construction of the "Imperial" pulley, permitting the renewal of these parts readily, enables the user to keep the pulleys in perfect repair and running order.

The advantages of equipping the line shaft with clutch pulleys are well-known and appreciated. By this arrangement the belts stand still when not at work, avoiding wear and tear, and also saving the power which would be required to keep loose pulleys and belts in motion. The only valid objection heretofore has been that if a friction-clutch pulley on the line shaft should slip and need adjustment, the entire line of shafting would have to be stopped for this purpose, or the pulley would have to be thrown out of clutch, losing the work of the machine it was driving until the shaft could be conveniently stopped and the friction of the pulley increased. This objection has been entirely overcome in the "Imperial" clutch pulley. Owing to its manner of construction the friction disk is the only part of the pulley that is in motion when the pulley is out of clutch, the clutch mechanism and the balance of the pulley being loose on the shaft. Therefore, should an "Imperial" driving pulley on the line shaft slip at any time, the pulley can be thrown out of clutch and the adjustment of friction effected without stopping the shaft. This feature is of decided advantage to any establishment, permitting the constant and continuous motion of the line shaft.

The "Imperial" clutch pulley also enjoys freedom from injurious effects due to centrifugal force. The resistance is in direct line with the strain, and, consequently, centrifugal force does not exert a twisting strain upon the clutch members or throw them out of balance. As the friction rings move parallel to the shaft, centrifugal force cannot accidentally throw the pulley in or out of clutch. The permanent balance of the clutch mechanism and pulley being assured, and centrifugal force having no effect on the action of the pulley, there is apparently no limit to the speed at which the clutch may safely be driven.

The large friction surfaces and the manner of applying the friction make the pulley very positive and reliable in action, and it will transmit all the power exerted by a belt of the size for which it is made. The "Imperial" friction-clutch pulley is free from complicated devices, has few parts, occupies comparatively small space on the shaft, is light-running and powerful. The fact that it combines all of the essentials of a first-class pulley, with freedom from difficulties heretofore encountered with other makes, should make it a most attractive appliance and insure its widespread adoption. The manufacturers, Messrs. J. W. Penfield & Son, also produce a full line of power-transmitting machinery of all kinds at their extensive works at Willoughby, Ohio.

McGowan's Duplex Steam-Pump.

THE engravings herewith show a sectional view of the duplex steam-pump manufactured by the John McGowan Co. of Cincinnati, Ohio (Fig. 1. and Fig. 2); their patented non-slippage pump-valve seat (Fig. 3); and also the valve seat in general use, for comparison (Fig 4).

The general design of this pump is arranged with a view to giving the maximum of strength and an easy access to all parts requiring examination or adjustment. The introduction of the water to the cylinders is by gravitation, therefore maintaining a priming in the water-cylinders after the pump has ceased working. The position of the valve insures a free discharge of any air that may enter the pump through suction-pipe or packing-box.

The levers of the steam-valve motion work on a common center, one being the axis of the other. They are of equal length and are moved by the cross-head fastened on the steam piston-rods. The right-hand lever, looking from the water-end, is part of the outside thimble-shaft *L* (Fig. 2), resting in the stand journal, and is shown at *A* (Fig. 1). The projecting lug *B* is a part of the thimble. When the lever *A* is moved by the right steam-piston, the slide-valve of the left steam-cylinder will be moved by the link *C* coming in contact with the collars on the valve-stem. The left-hand lever *D*, when moved by the left-hand piston, will perform a like office for the right-hand steam-cyliner through the central spindle *M*, to which the wiper *N* is attached, and operates the lower link *E* and its contact with valve-stem collars. The standard supporting the valve motion is made in two parts and is adjustable, to take up wear, and is also a guide for the valve-stems to keep them in line. Lost motion caused by the wear of the part of the valve-gear is compensated by the adjustment of the collars on the valve-stems by bringing them closely together to insure the full stroke of the steam slide-valves. The use of this valve motion in the duplex pumps has proved satisfactorily that this type of pump can be so operated that the pistons will make a full and uniform stroke.

Previous to the introduction of the improved valve-seat there was no valve-seat in use where the flat elastic valve could be used satisfactorily, for the reason that its use was endangered by the liability of its changing its position after seating for a considerable time without turning, which would form by the pressure projection between the radial arms, or, if covering a grating, with

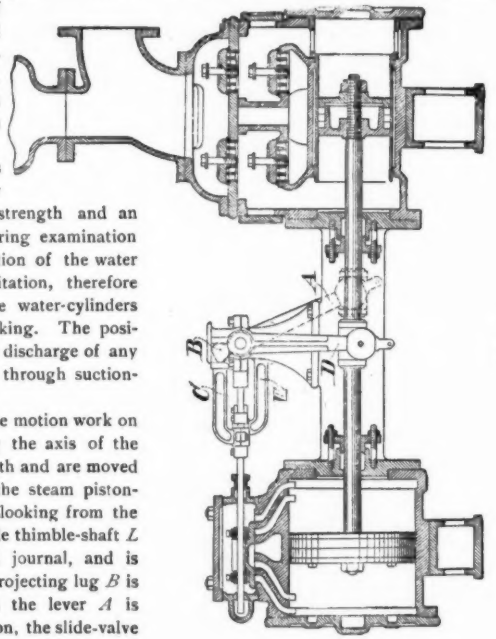


FIG. 1.

McGOWAN'S DUPLEX STEAM PUMP.

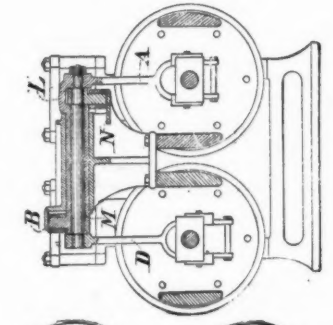


FIG. 2.

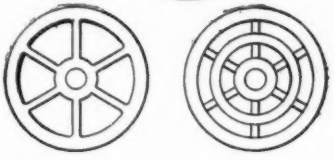
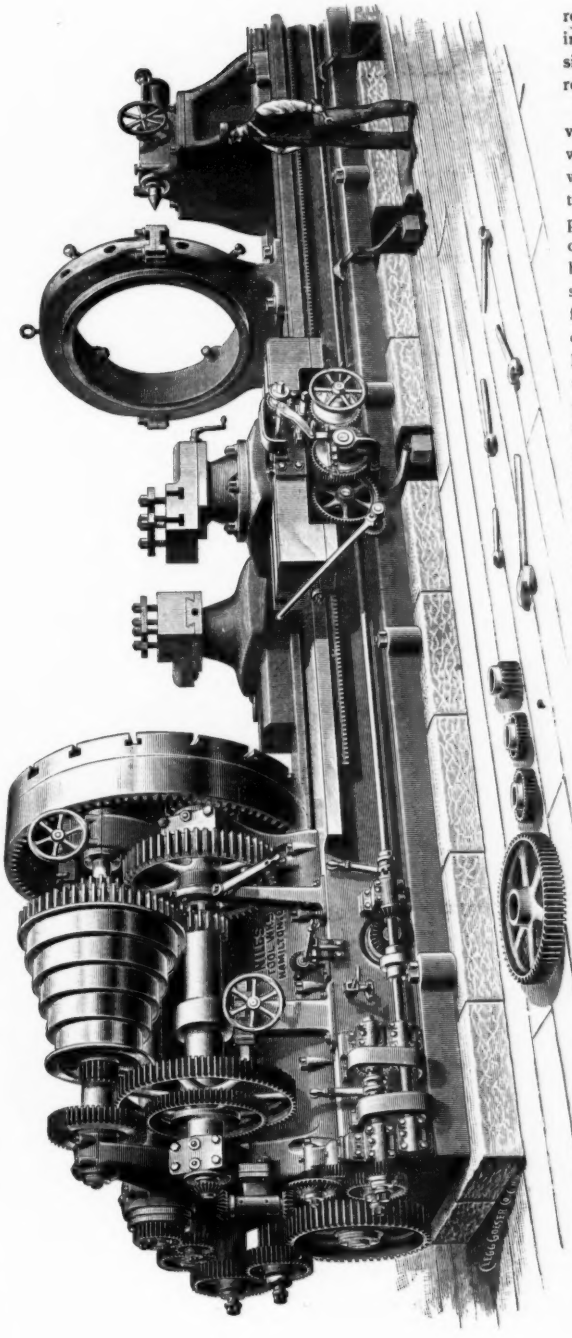


FIG. 3.

FIG. 4.



round or other shaped openings, corresponding depressions with the grating would result.

It is obvious that such a valve, should the spring get weak or broken to allow the valve or valves to turn on their axes, or should the pump-valve or valves get out of place and be turned by hand or changed in position by any other cause from that in which it was originally, that it would no longer seat perfectly, and where a number in the same pump should be slightly turned, the pump would fail to take water and would practically destroy the pump's action, even should the pump be primed. These conditions with the old style valve-seat are a known fact to all who have handled pumps.

A 90" Forge Lathe.

We illustrate herewith a massive lathe designed and built by the Niles Tool Works Co., Hamilton, Ohio, for boring and turning steel ingots used in the construction of heavy ordnance for the United States Government. The general dimensions of this machine are as follows: Actual swing over the ways, 91"; swing over the carriage, 70". The bed is 60' 6" long, taking between centers, 45', arranged with triple-shear tied together by a continuous web and with heavy cross-girts. The weight of the bed alone, 60' 6" long, is 110,000 lbs. The main spindle is a steel forging, with front bearing 16" diameter, 24" long. The service this tool is required to do in boring ingots imposes

very unusual strains on the spindle, and in order to take up the thrust the spindle is provided with seven thrust-collars, enabling it to withstand an end pressure of 200,000. The area of the collars is sufficient to reduce the pressure to 500 lbs. per square inch. The lathe is powerfully geared to stand this enormous duty. The driving-cone has five steps for 6″ belt, and is so geared that there are twenty changes of speed to the face-plate. All the gearing of the head-stock is steel, castings or forgings, cut from the solid, of heavy pitch and great strength in all proportions.

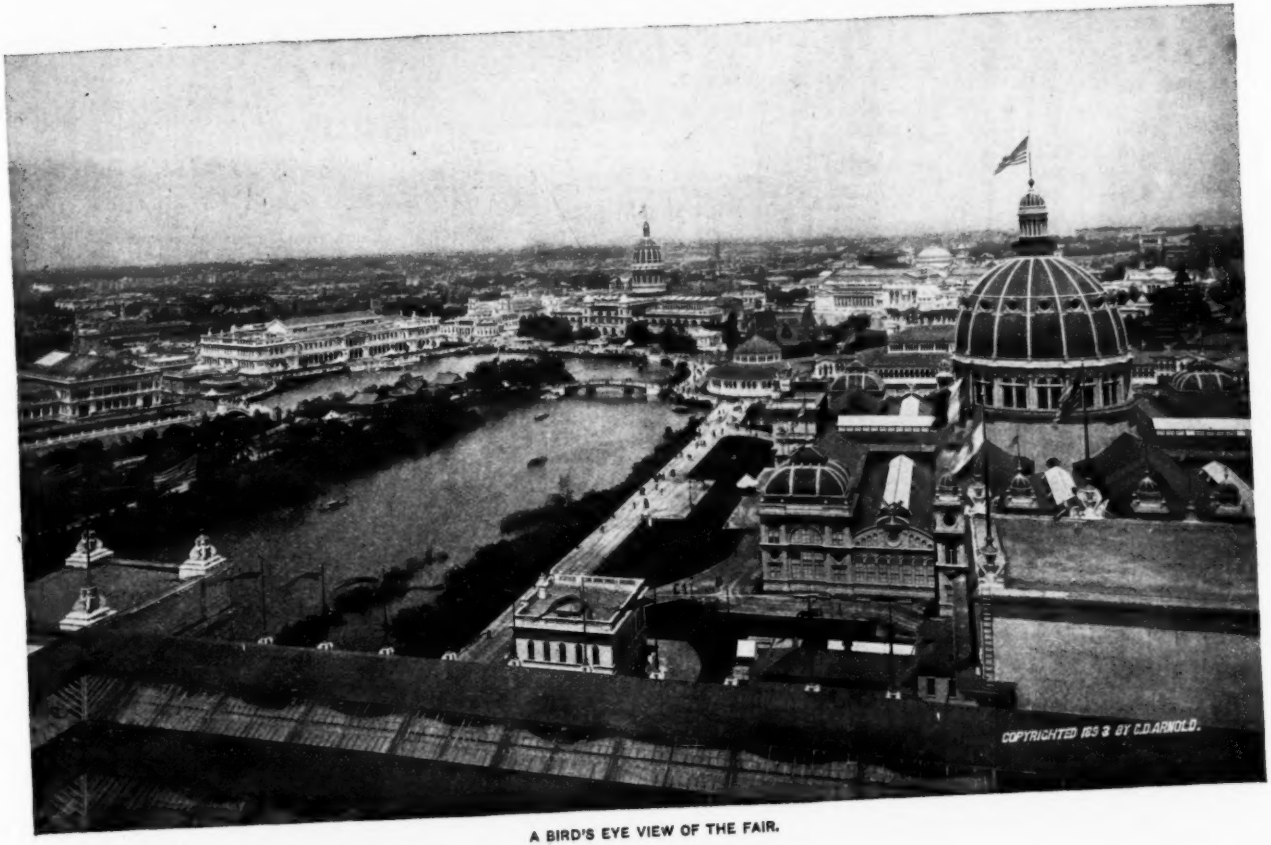
The carriage is of massive proportions, clamped its total length on the outside of the bed, and by two clamps on the inside of the bed equal in length to the width of the bridge of the carriage, and is provided with taper-gibs for adjustments. The carriage carries two substantial tool-posts, one in front, with compound movement, and one in the rear. The carriage is traversed for feed and quick movement by three separate and independent movements, one movement being by means of the lead-screw, which is 6–1/2″ diameter, one continuous forging 60′ 6″ long. This screw is placed in the center of the bed in a groove provided for the purpose, and arranged with coverings to protect it from dirt and chips. The thrust in the lead-screw is provided for in a manner similar to the spindle by means of thrust-collars. The bronze feed-nut engaging with the lead-screw in the carriage is 36″ long, very accurately fitted and the weight of this nut alone is 1200 lbs. Provision is also made for moving the carriage independent of the lead-screw and rod-gears, by shaft driven from an independent counter-shaft, giving a quick-traverse to the carriage of 10′ per minute. A safety device is provided, making it impossible to throw the quick-traversing gears into engagement at the same time with the feed-nut on the lead-screw. The tail-stock is secured to the bed by four bolts, engaging with "T"-slot in the bed, and it is traversed on the bed by ratchet-lever operating a pinion into a rack on the bed. The lathe is provided with steady-rests having ring-bearings for sustaining heavy work. The large one will take 60″ in diameter, the load being sustained by a ring-bearing having over 1200 square inches of projected area. The lathe has sufficient strength and stiffness to carry a load between centers weighing about 60 tons, and to perform the necessary cutting operations. In the steady-rests shafts or ingots weighing over 200 tons can be operated upon successfully. Gross weight of the lathe complete, 130 tons.

THE WORLD'S FAIR IN RETROSPECT

A SOUVENIR NUMBER OF

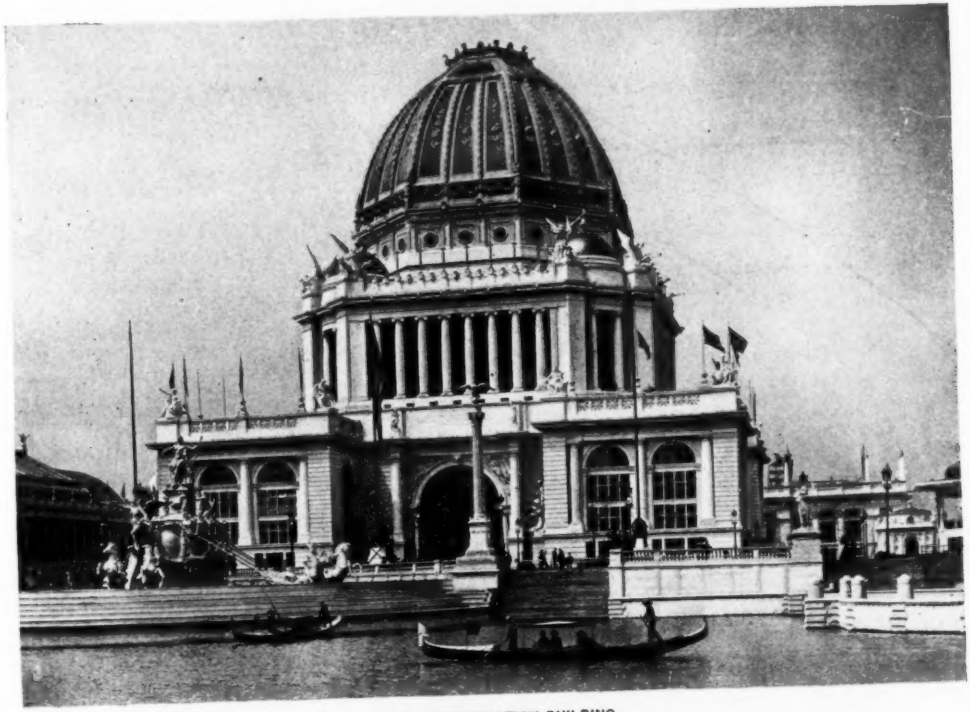
THE ENGINEERING MAGAZINE

SPECIALLY DESIGNED TO INDICATE THE PRACTICAL VALUE OF THE WORLD'S COLUMBIAN EXPOSITION TO THE SCIENCE AND INDUSTRY OF THE TIME

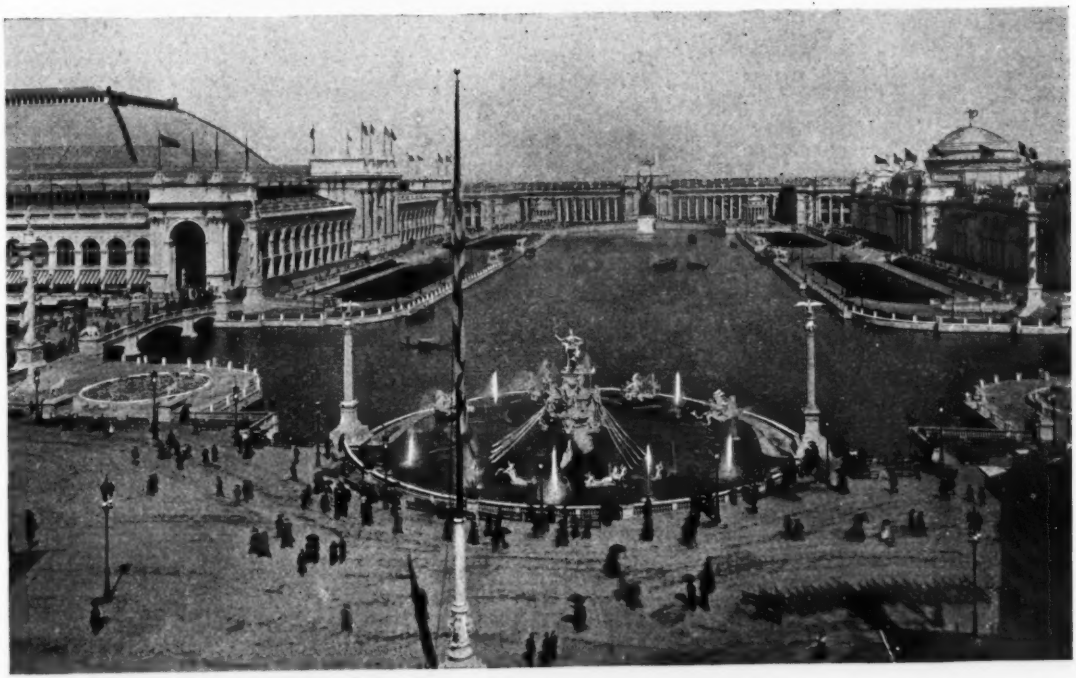


A BIRD'S EYE VIEW OF THE FAIR.

A VIEW OF THE FAIR FROM THE MIDWAY PLAISANCE.



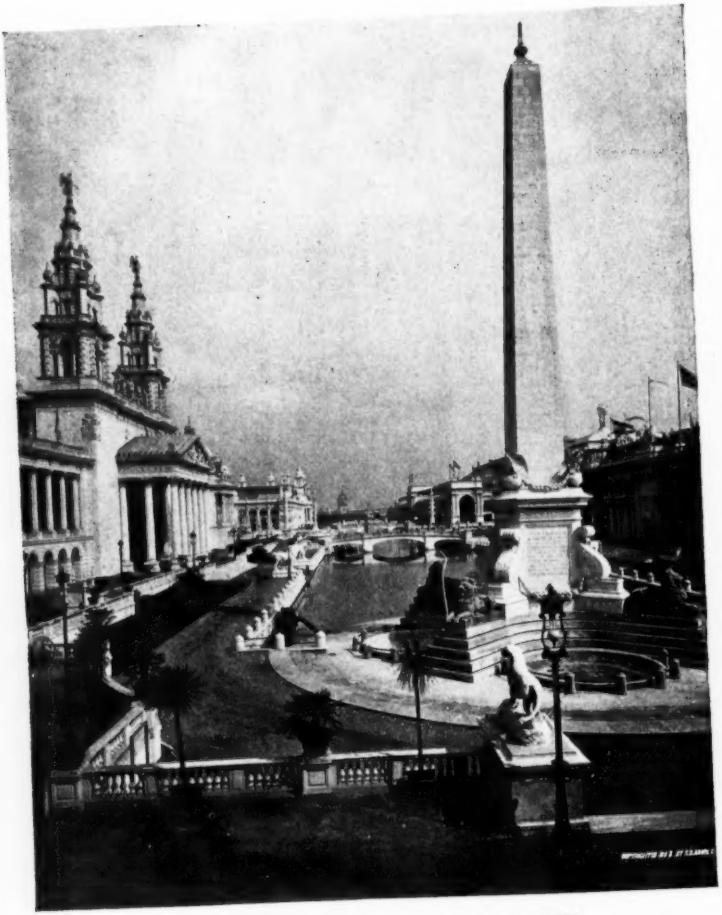
THE ADMINISTRATION BUILDING.



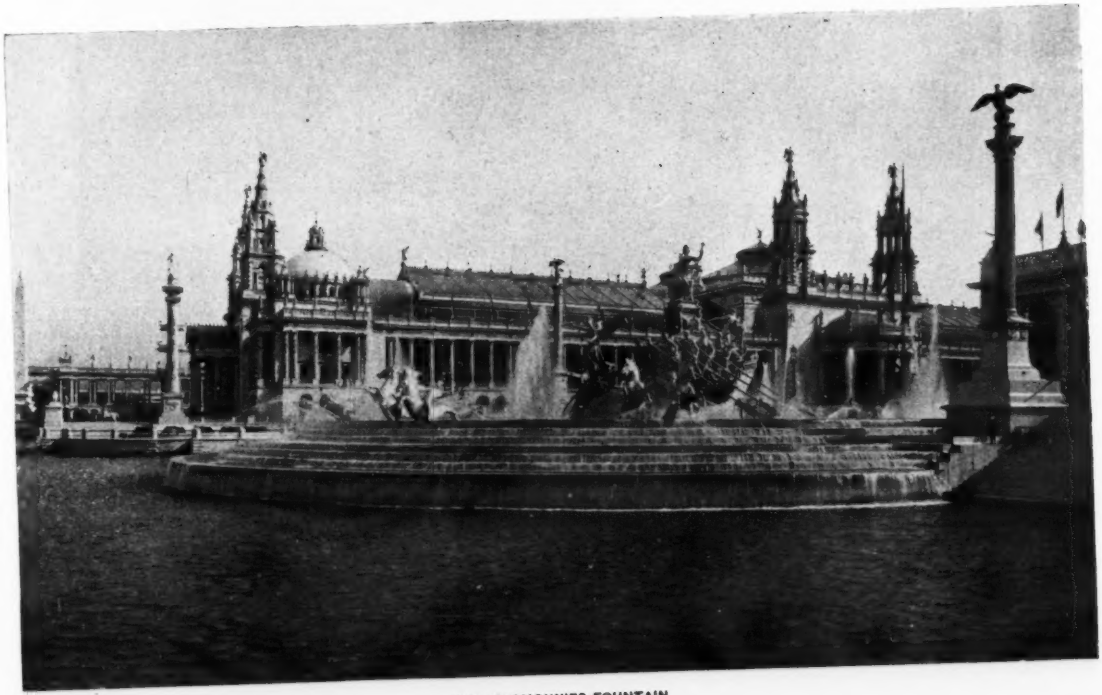
THE COURT OF HONOR, FROM THE ADMINISTRATION BUILDING.

THE COURT OF HONOR, FROM THE PERISTYLE.

THE PERISTYLE AND THE STATUE OF "THE REPUBLIC."



THE COURT OF HONOR LOOKING FROM THE SOUTH.



THE MACMONNIES FOUNTAIN.

MANUFACTURES AND LIBERAL ARTS BUILDING.

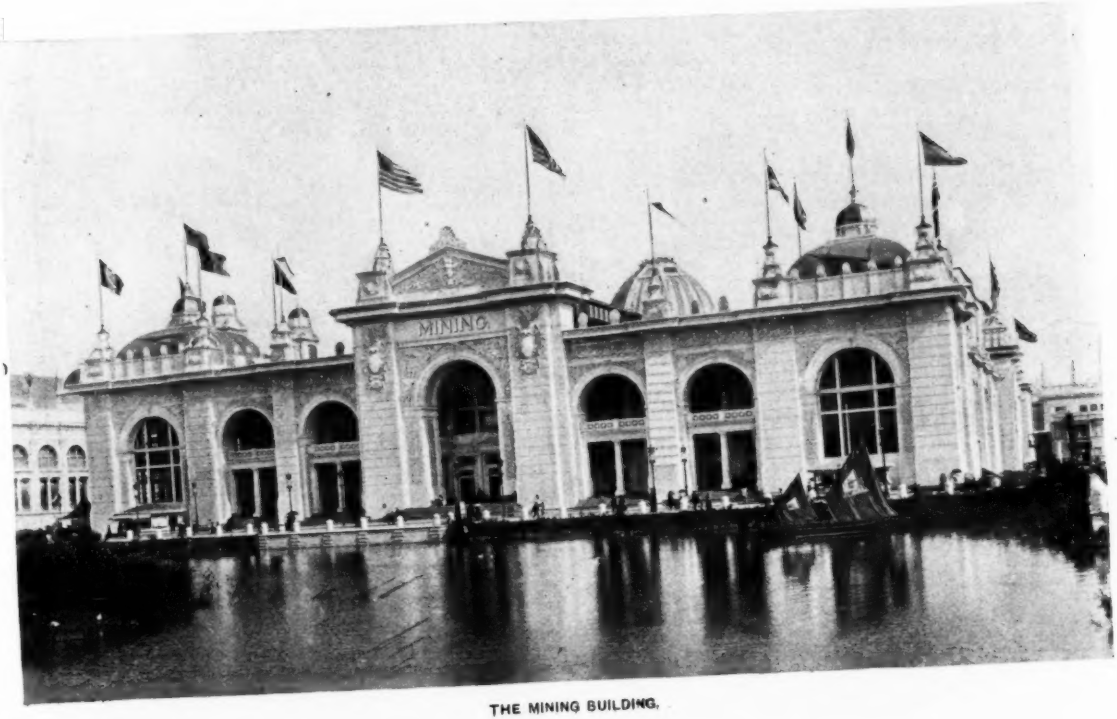
INTERIOR VIEW OF THE LIBERAL ARTS BUILDING.

THE ELECTRICITY BUILDING.

THE PALACE OF MECHANIC ARTS.

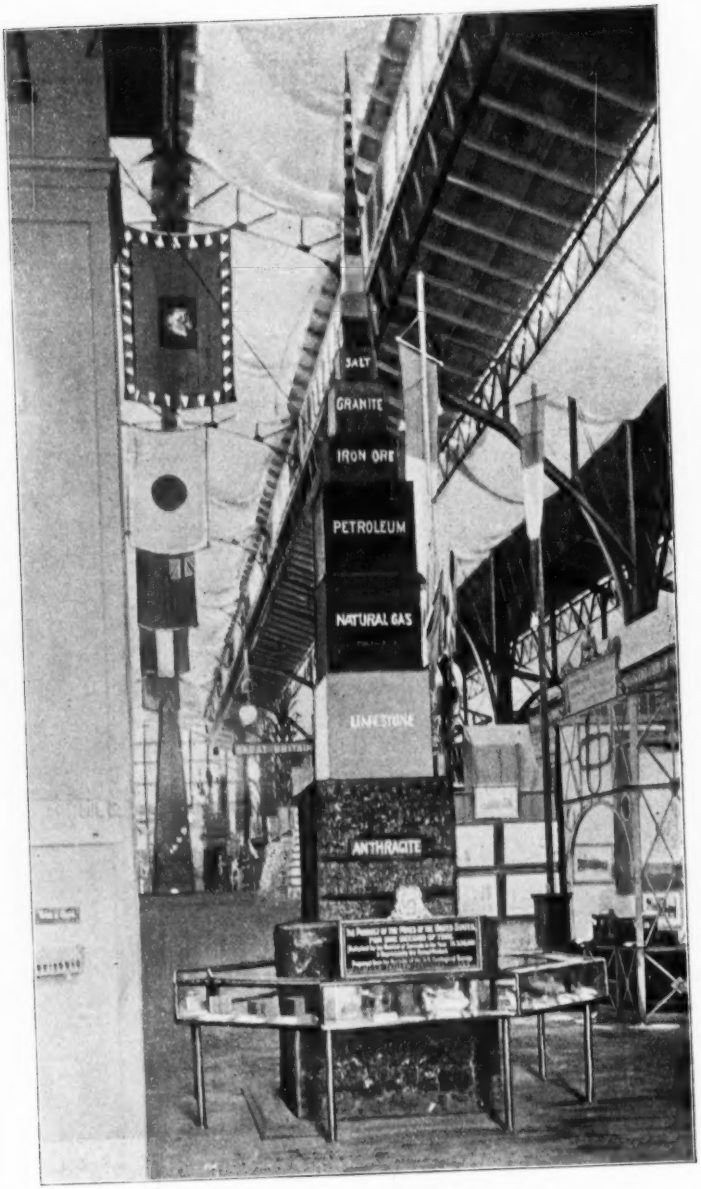
THE AGRICULTURAL BUILDING.

A VIEW IN THE AGRICULTURAL BUILDING.



THE MINING BUILDING.

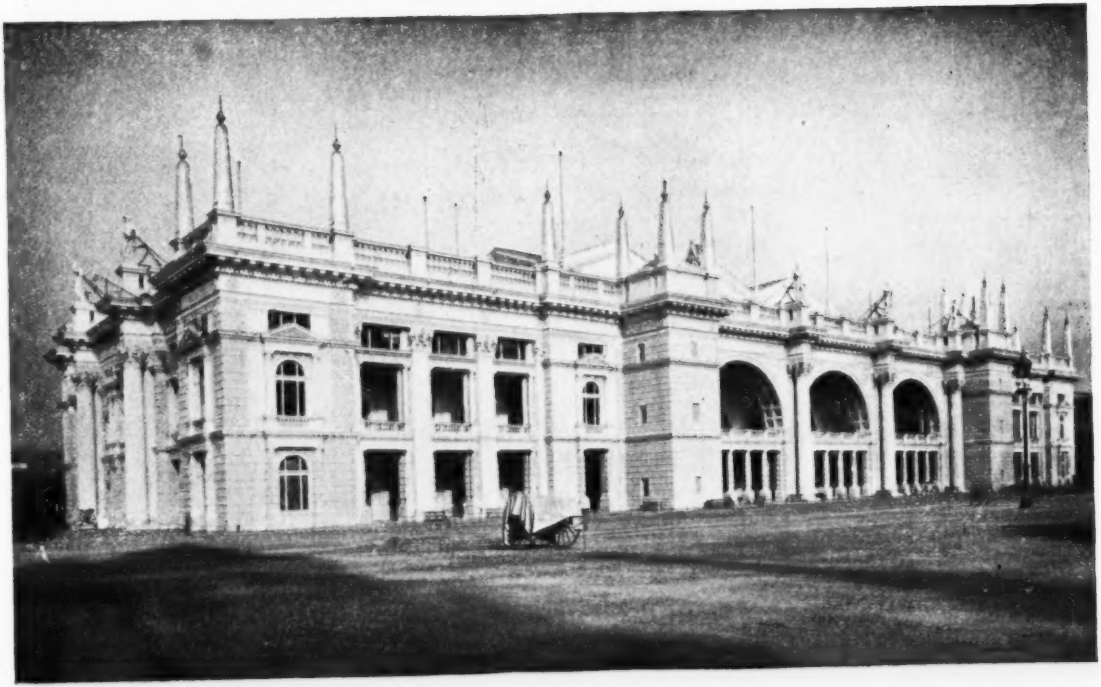
NEW SOUTH WALES EXHIBIT IN THE MINING BUILDING.



COLUMN ILLUSTRATING MINERAL PRODUCTION.

A VIEW IN THE MINING BUILDING.

THE MONTANA EXHIBIT IN THE MINING BUILDING.

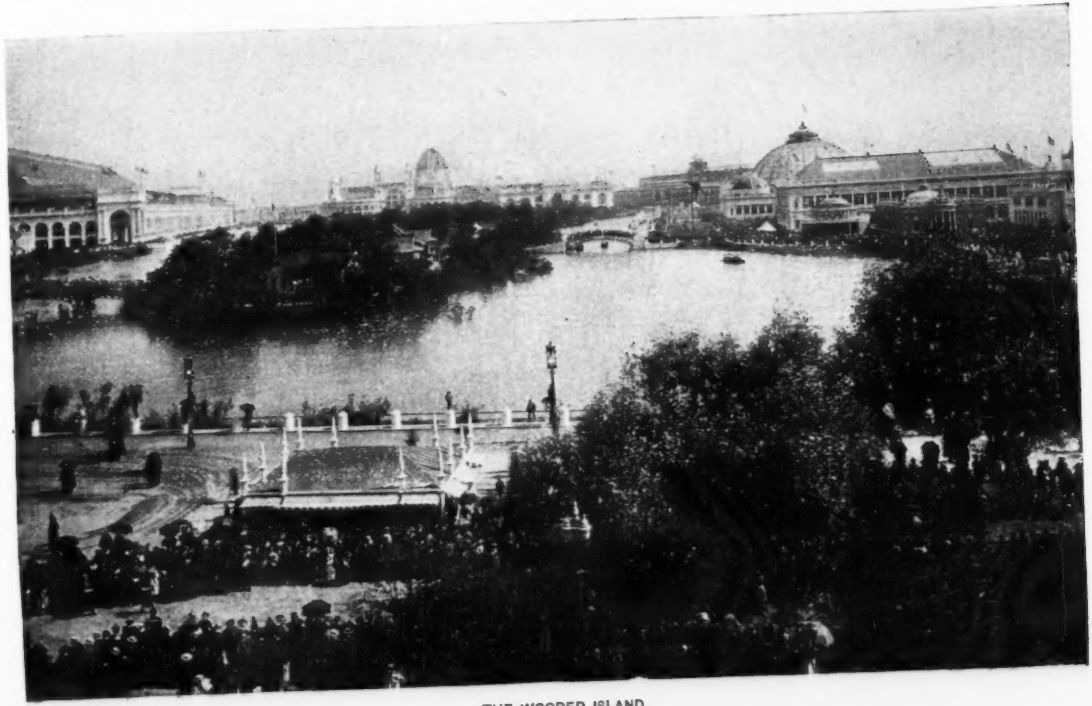


THE TERMINAL STATION.

LOADING AND UNLOADING ILLINOIS CENTRAL TRAINS AT THE FAIR.

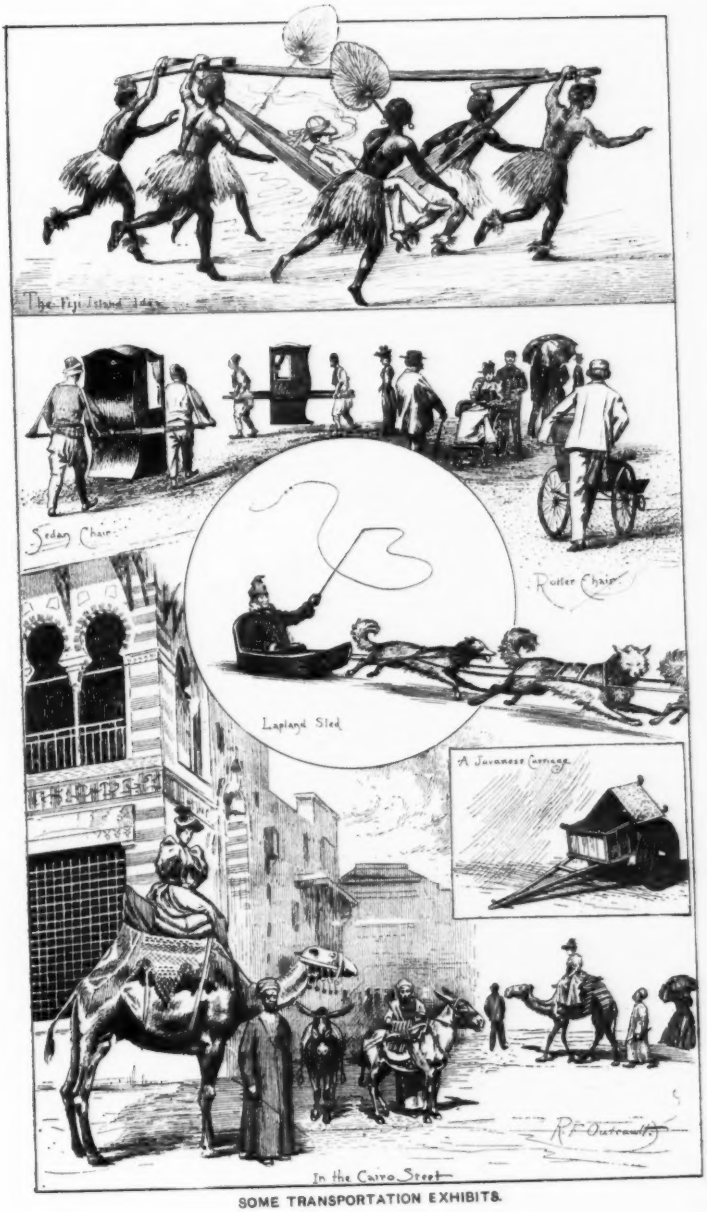
THE TRANSPORTATION BUILDING.

A VIEW IN THE TRANSPORTATION BUILDING.



THE WOODED ISLAND.

THE FINE ARTS BUILDING.



SOME TRANSPORTATION EXHIBITS.

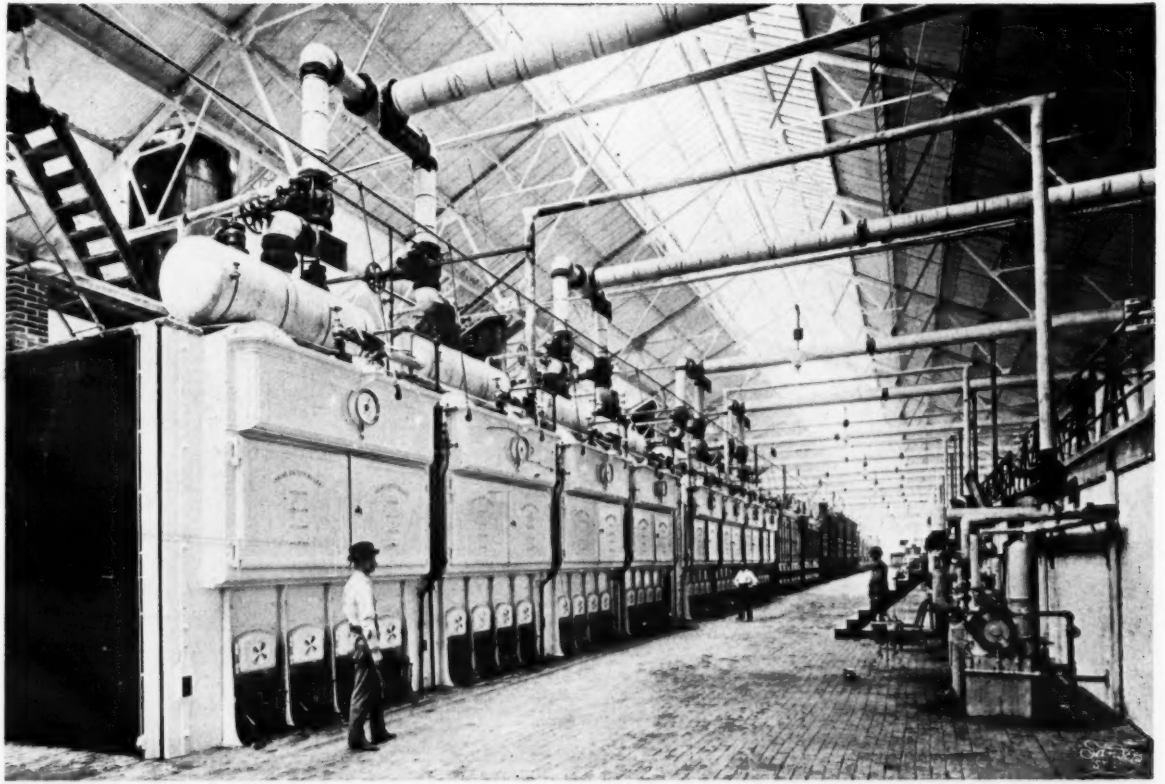
THE HORTICULTURAL BUILDING.

THE FISHERIES BUILDING.

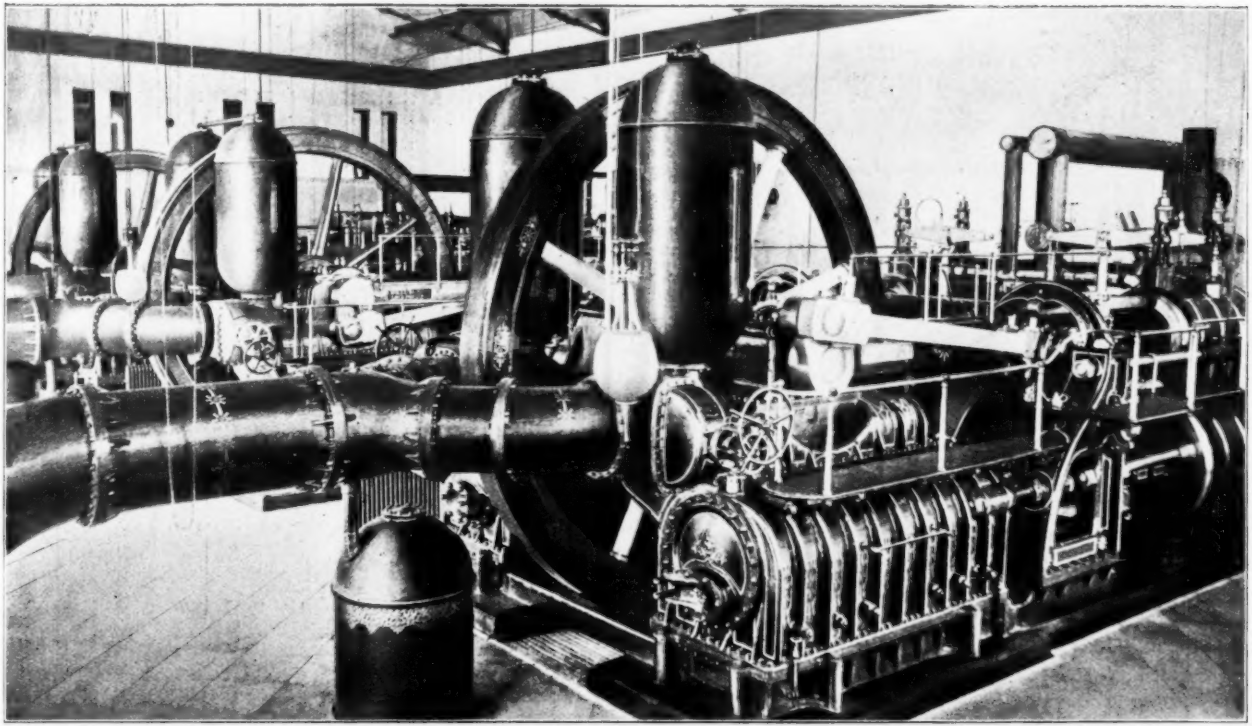
A VIEW IN THE FISHERIES BUILDING.

A GALLERY IN THE FINE ARTS BUILDING.

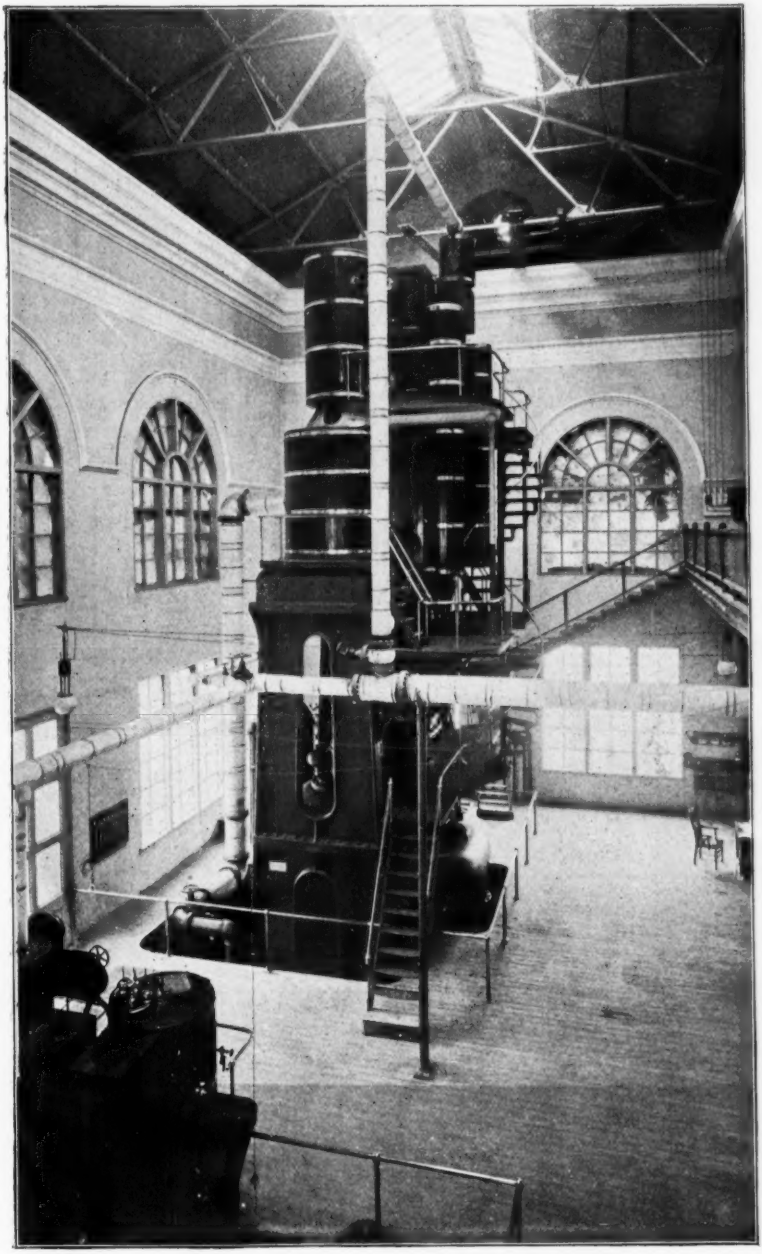
UNITED STATES GOVERNMENT BUILDING.



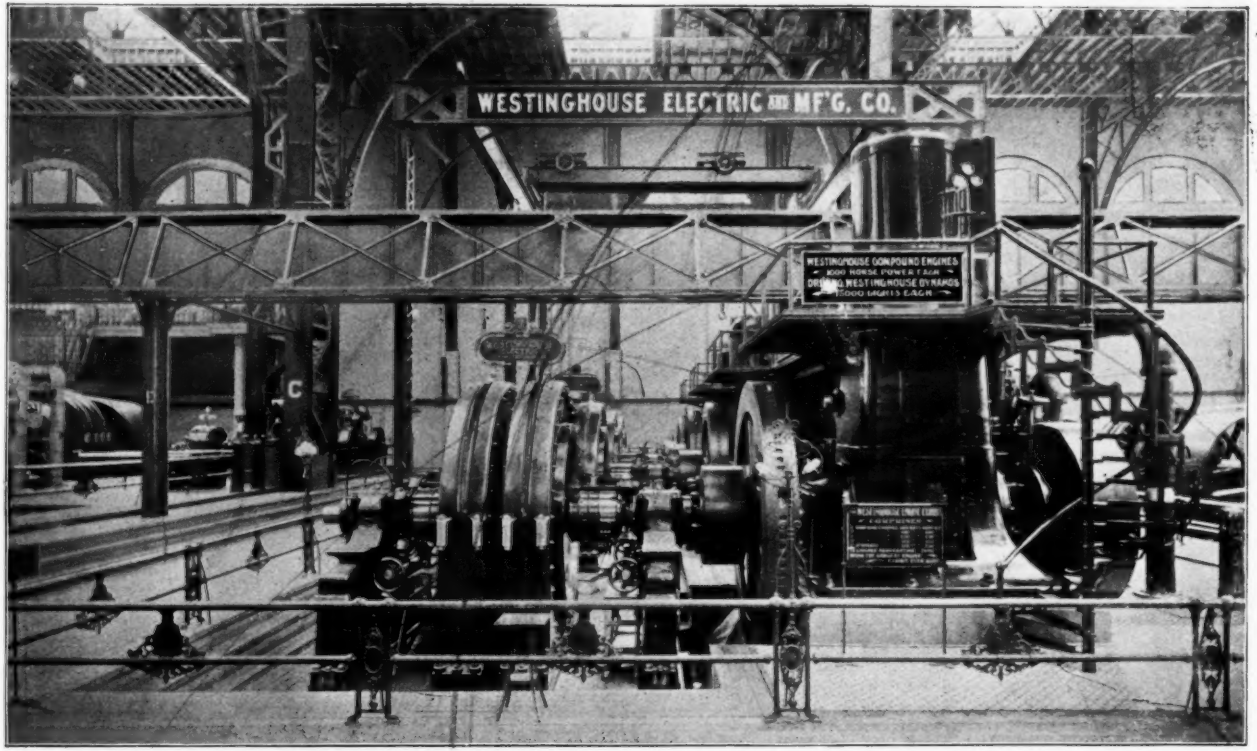
BOILER PLANT OF THE WORLD'S COLUMBIAN EXPOSITION—SHOWING THE HEINE SAFETY BOILERS.
One of the largest boiler plants ever installed. The Heine Boilers, aggregating 3000 H. P., in continuous operation during the Exposition.



THE HOLLY M'F'G CO.'S FOUR GASKILL HORIZONTAL HIGH DUTY PUMPING ENGINES.
Used to supply the World's Fair grounds with potable water from Lake Michigan. Total capacity, 48,000,000 U. S. Gallons per 24 hours.



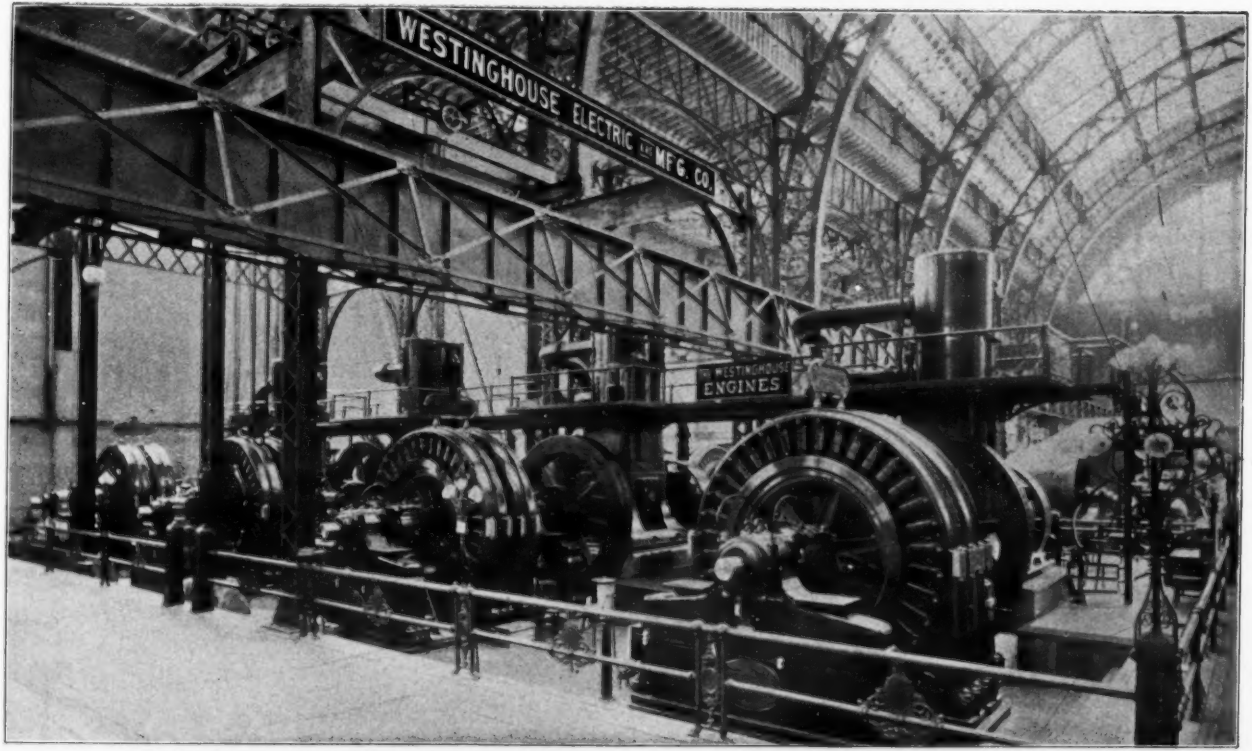
INTERIOR VIEW OF A PORTION OF THE PUMPING STATION.
Showing four Worthington Pumping Engines. Aggregate Daily Capacity 40,000,000 gallons.



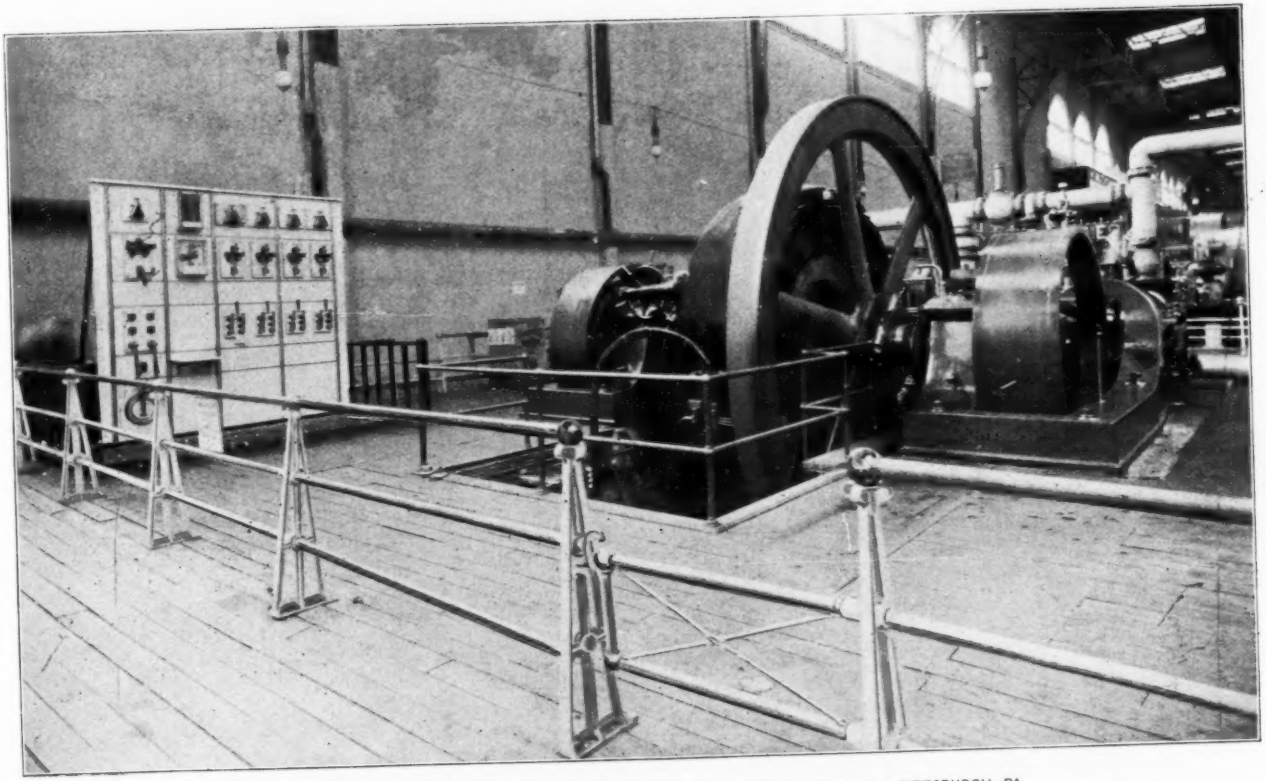
ELECTRICITY BUILDING—EXHIBIT OF THE WESTINGHOUSE ELECTRIC & M'F'G CO., PITTSBURGH, PA.

Showing an end view of the four 1000 H. P. Westinghouse Compound Engines connected with the 15,000 light Westinghouse Dynamos.

Showing an end view of the four 1000 H. P. Westinghouse Compound Engines connected with the 15,000 light Westinghouse Dynamos.



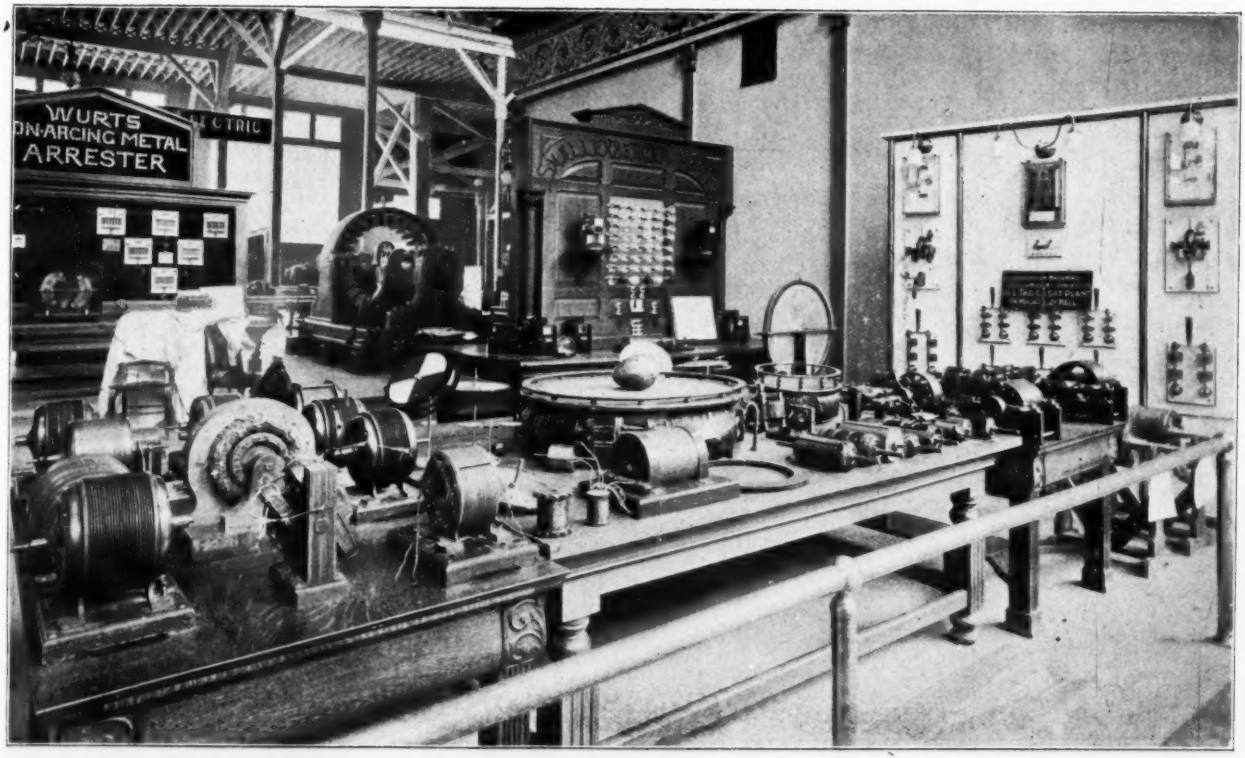
ELECTRICITY BUILDING—EXHIBIT OF THE WESTINGHOUSE ELECTRIC & M'F'G CO., PITTSBURGH, PA.
Side view of the four 15,000 light Westinghouse Dynamos, with the 1000 H. P. Westinghouse Engines in the background.



ELECTRICITY BUILDING—EXHIBIT OF THE WESTINGHOUSE ELECTRIC & M'F'G CO., PITTSBURGH, PA.

End view of the 750 H. P. 500 volt Power Generator. Connected direct to the Cross Compound Allis Engine; Switchboard for the Generator to the left.

End view of the 750 H. P. 500 volt Power Generator. Connected direct to the Cross Compound Allis Engine; Switchboard for the Generator to the left.

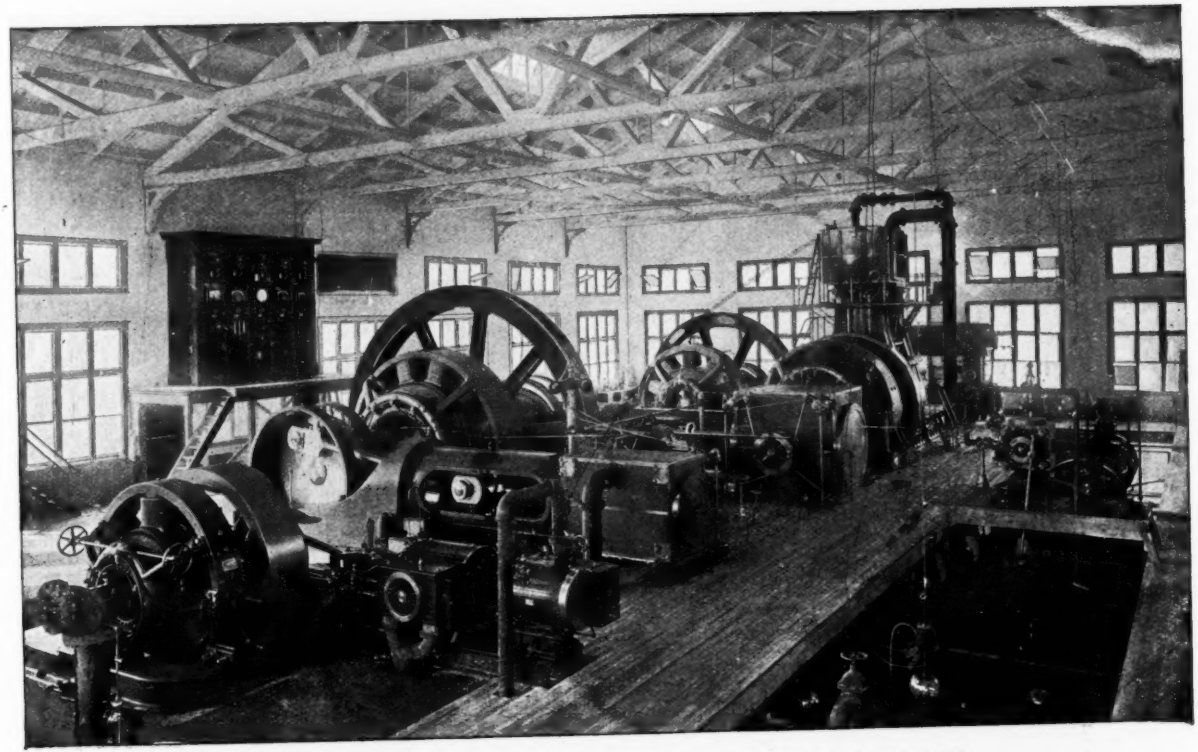


ELECTRICITY BUILDING—EXHIBIT OF THE WESTINGHOUSE ELECTRIC & M'F'G CO., PITTSBURGH, PA.
Showing Nikola Tesla's experimental apparatus in foreground, with Lightning Arrester and Meter, and Switchboard Instrument exhibit in the background.

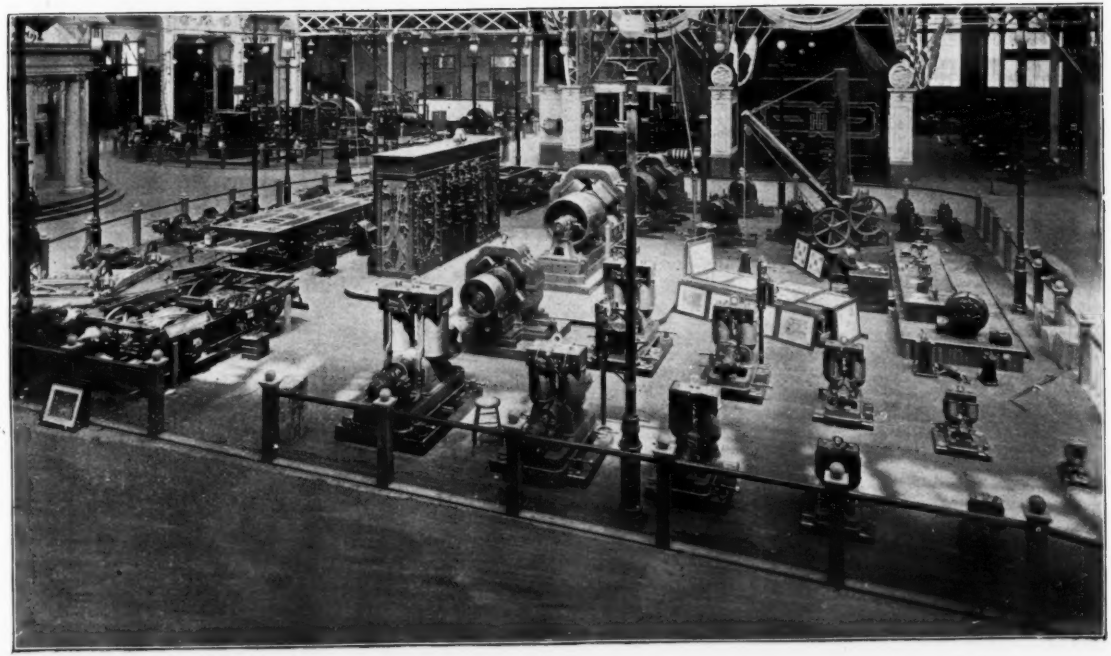
ELECTRICITY BUILDING—EXHIBIT OF THE WESTINGHOUSE ELECTRIC & M'F'G CO., PITTSBURGH, PA.

Showing Street Railway Generator, Motors, Controllers, and Complete Car Equipments.

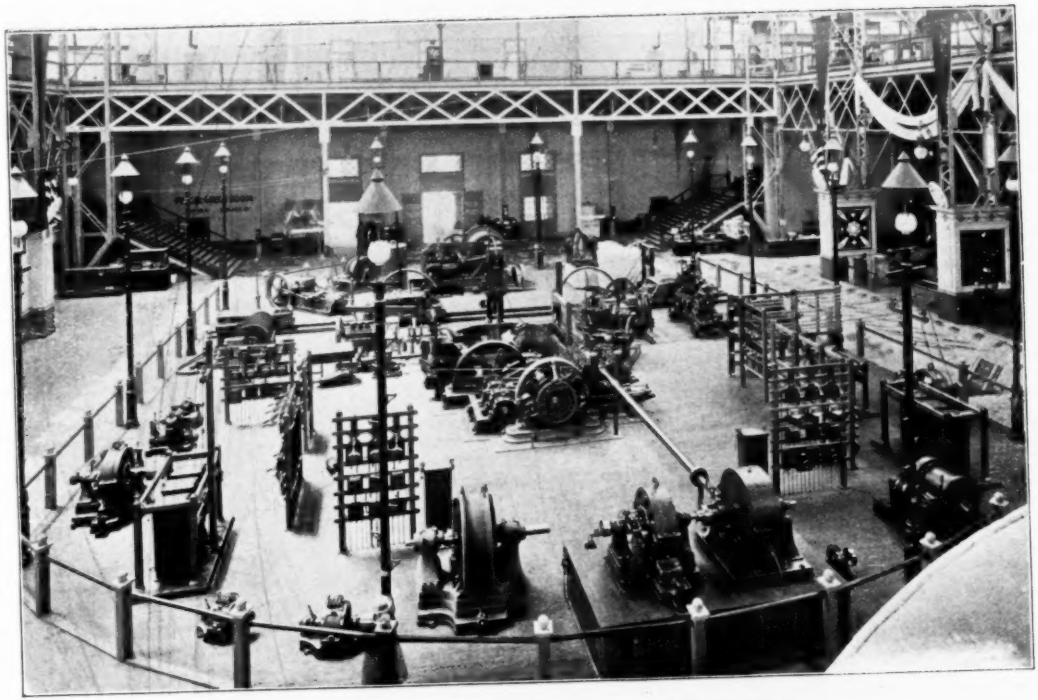
U. S GOVERNMENT EXHIBIT—FORESTRY DIVISION, AGRICULTURAL DEPARTMENT.
Illustrating the preservation of railroad ties by the use of the Q. & C. Company's Servis Tie Plate.



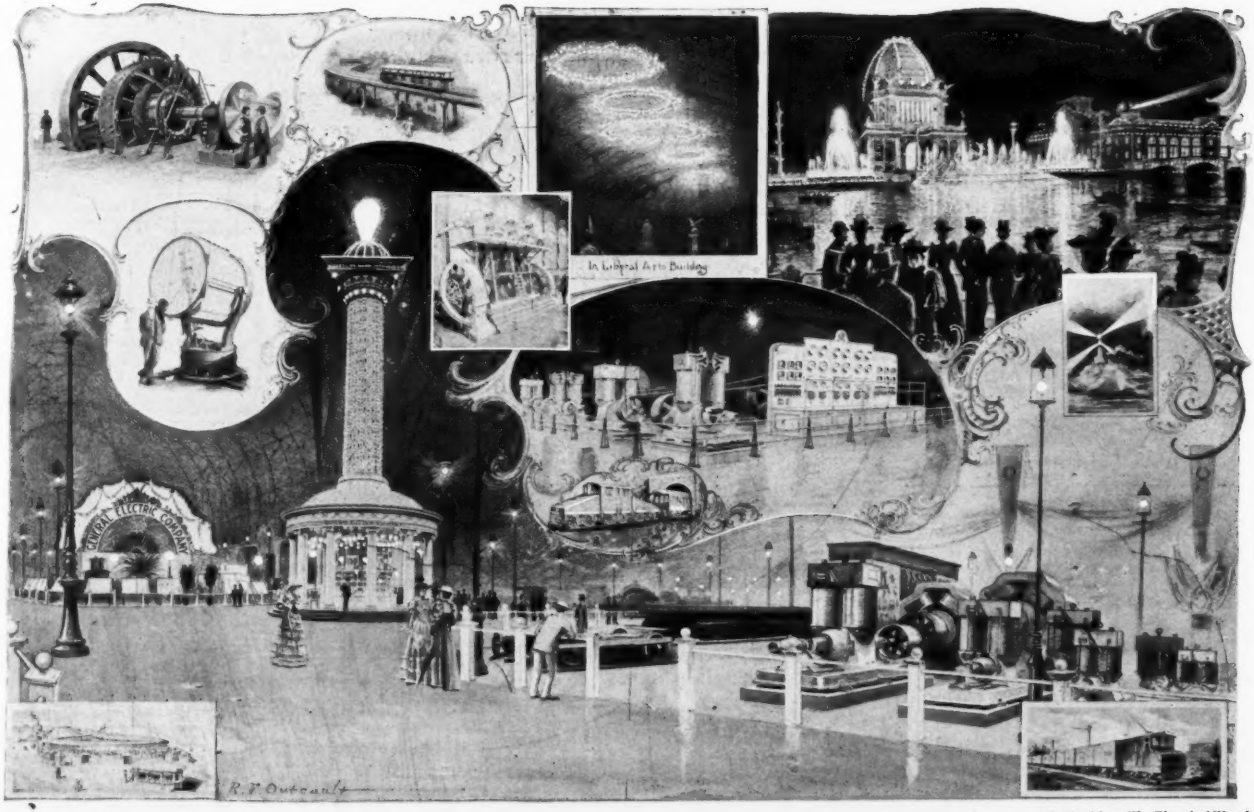
THE GENERAL ELECTRIC COMPANY—INTERIOR OF THE INTRAMURAL RAILWAY POWER-HOUSE.
The Largest Single Exhibit of Moving Machinery at the Fair.



ELECTRICITY BUILDING—RAILWAY AND MOTOR EXHIBIT OF THE GENERAL ELECTRIC CO.



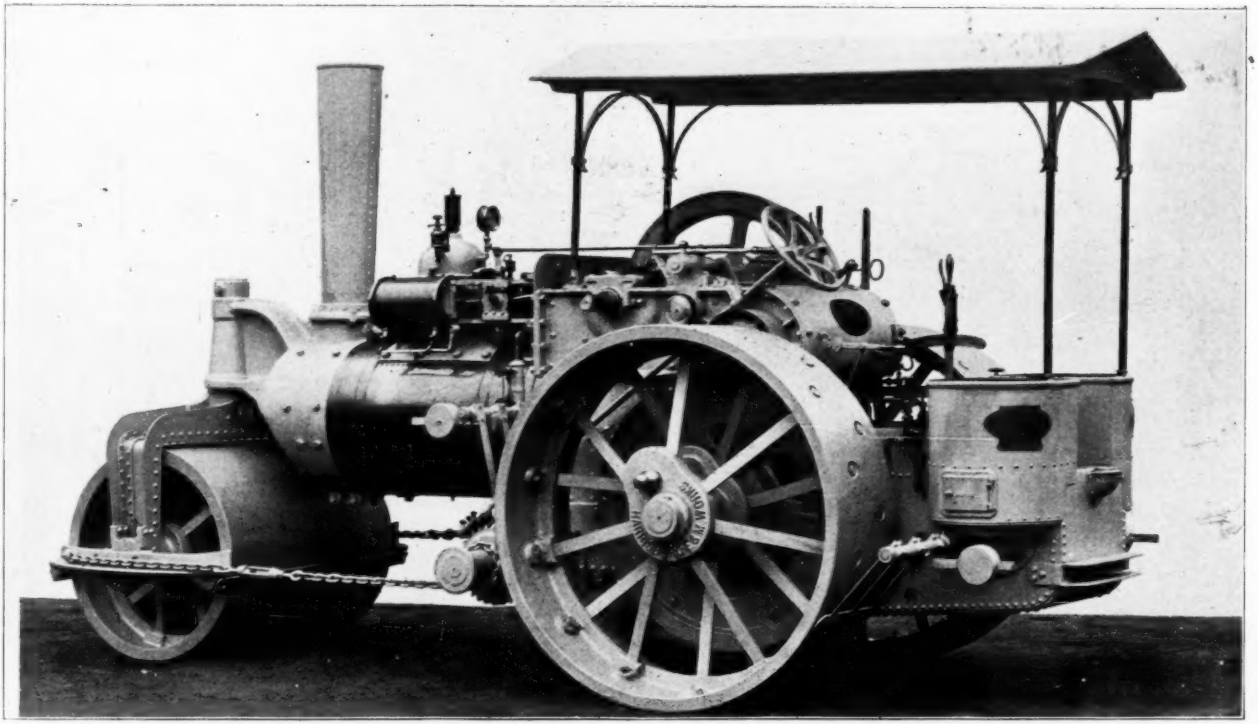
ELECTRICITY BUILDING—MINING EXHIBIT OF GENERAL ELECTRIC COMPANY.
Model Three-Phase Power-Transmission Plant in the foreground.



Revised from The Electrical World.

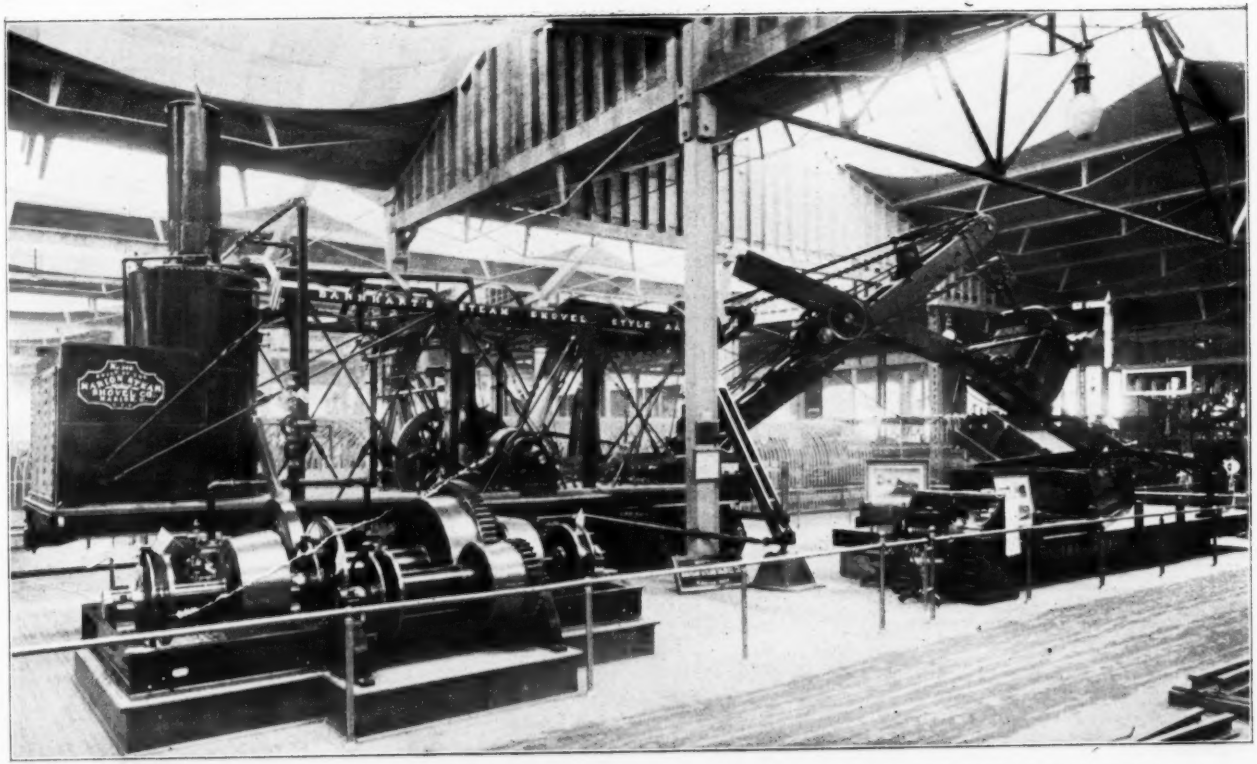
ELECTRICITY BUILDING—LEADING FEATURES OF THE GENERAL ELECTRIC COMPANY'S EXHIBITS.

2000 H. P. Railway Generator.
Largest Search-Light in the World.
Movable Sidewalk.
Intramural Railway.
The Great Generator.
Tower of Light.
Service Plant, Machinery Hall.
90 Ton Locomotive.
Railway Exhibit.
Electric Fountains.
Battle-Ship.
30 Ton Locomotive.

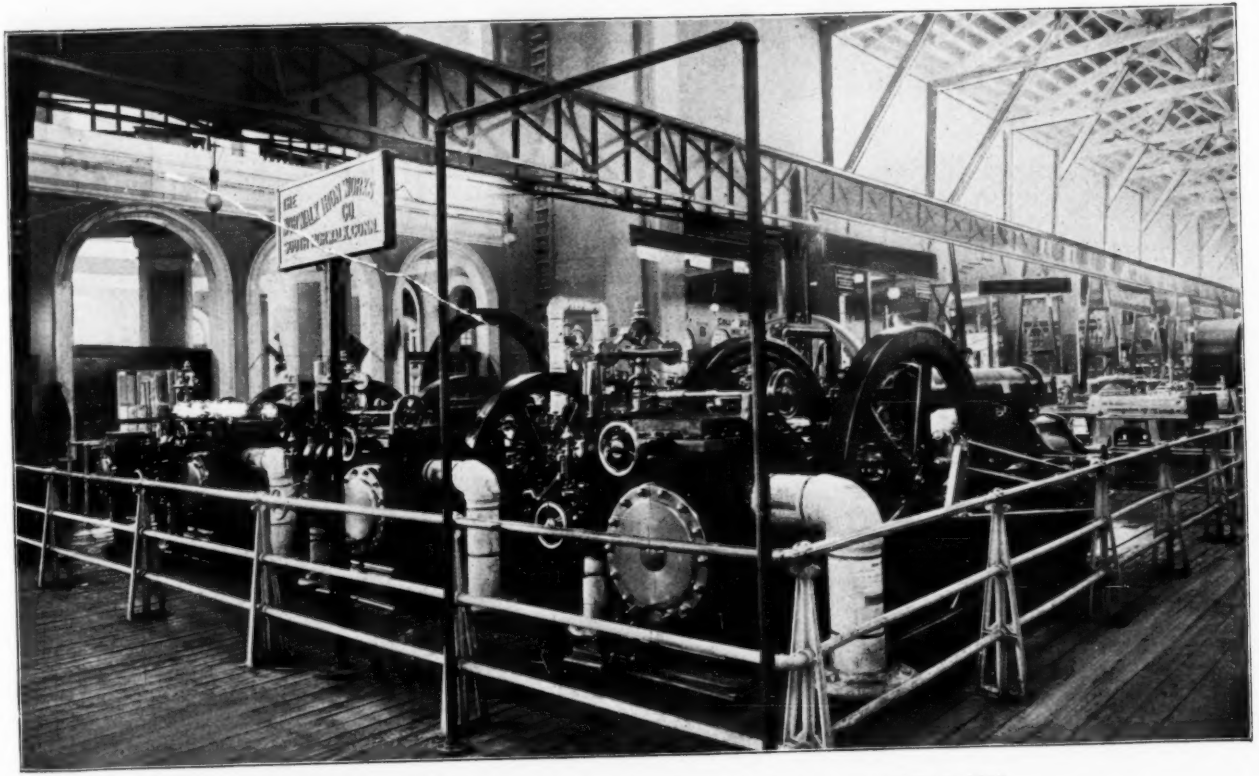


THE HARRISBURG STEAM ROAD ROLLER—HARRISBURG FOUNDRY & MACHINE WORKS. HARRISBURG, PA.

Actively employed for 18 months in making the road-ways of the Fair grounds.



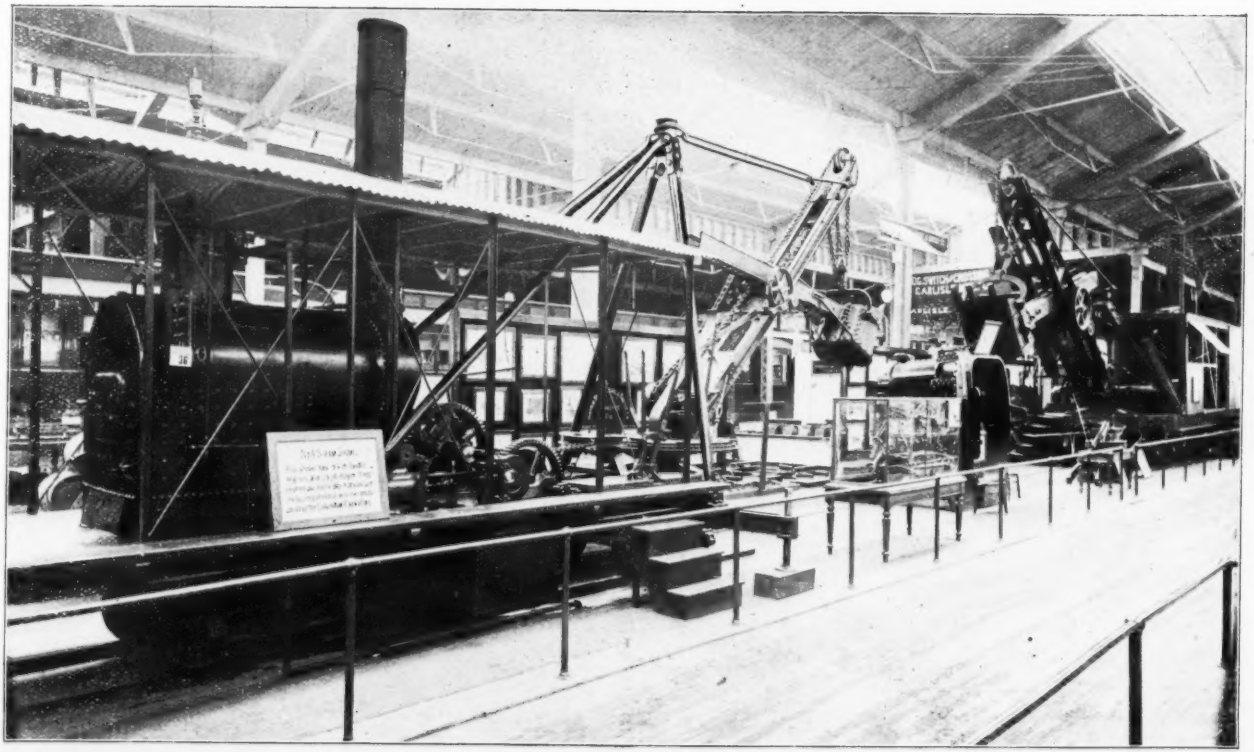
TRANSPORTATION BUILDING—EXHIBIT OF THE MARION STEAM SHOVEL CO., MARION, OHIO—STEAM SHOVELS, DREDGES, EXCAVATORS, ETC.



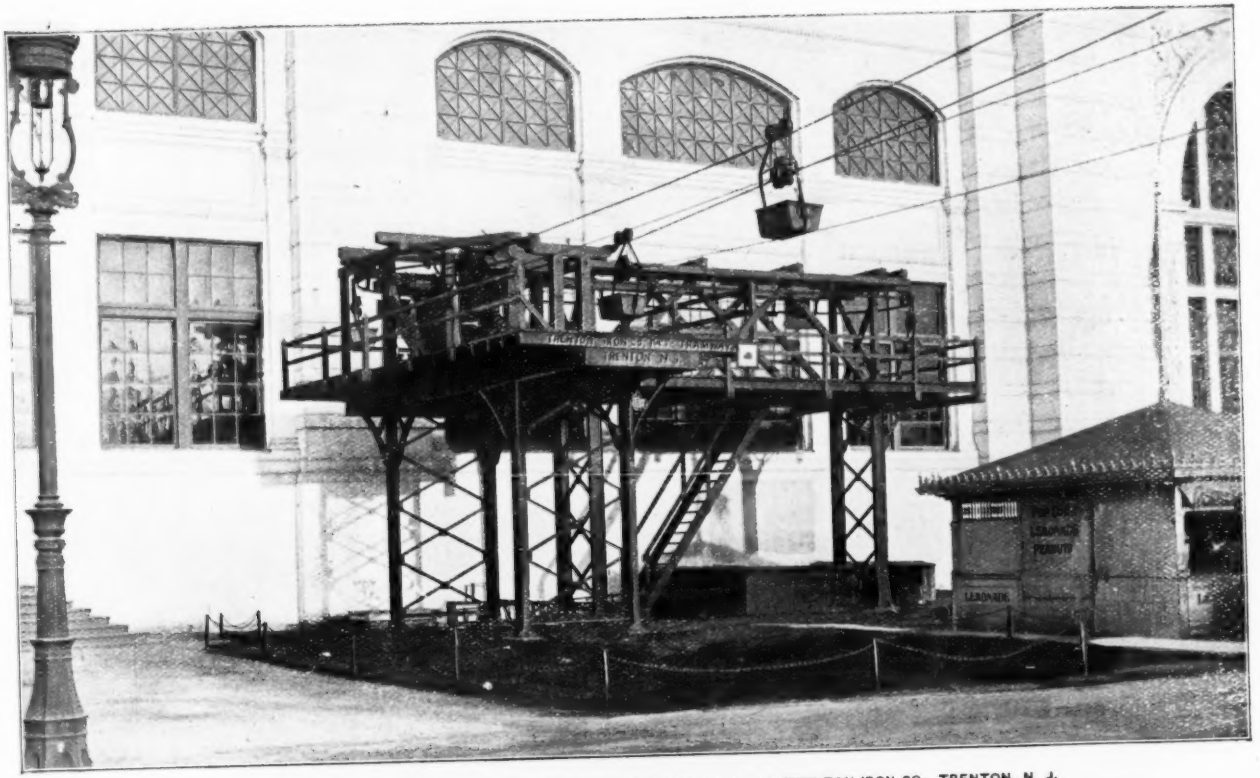
TRANSPORTATION BUILDING—EXHIBIT OF THE NORWALK IRON WORKS CO., SO. NORWALK, CONN.

Showing four Norwalk Air Compressors, actively employed night and day for nearly 18 months for bunding and exhibition purposes.

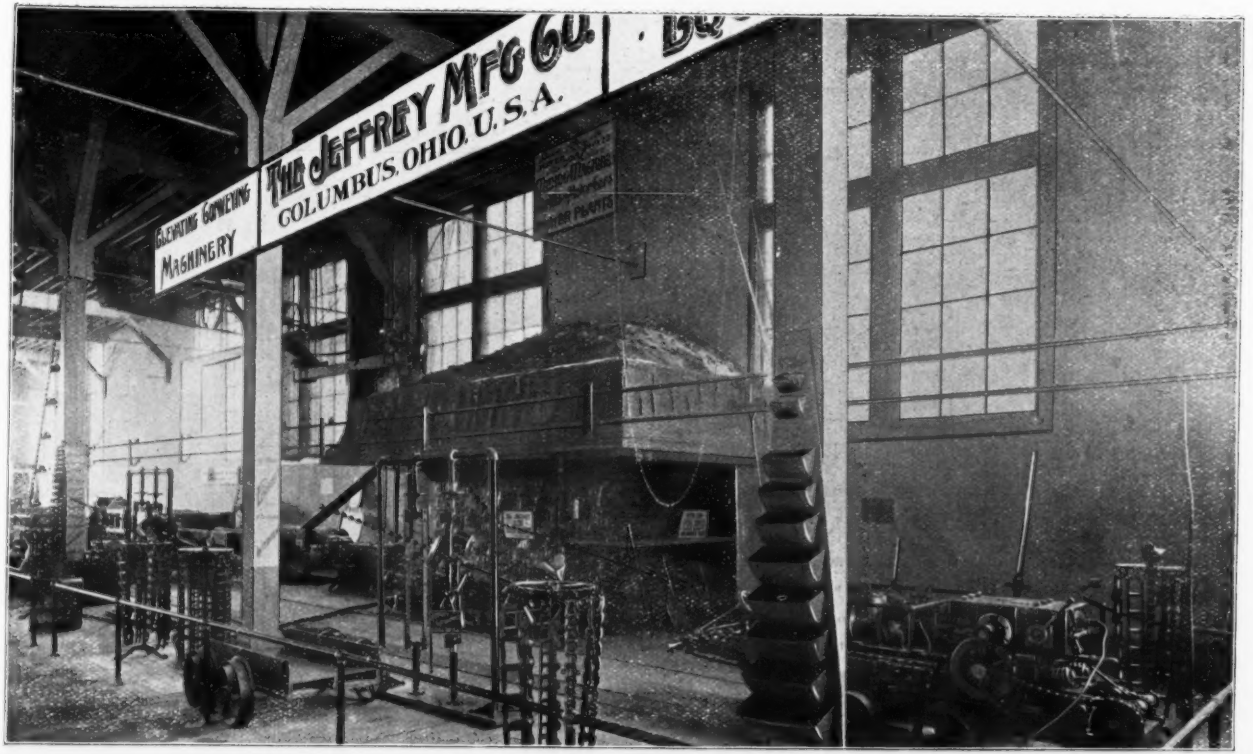
Showing four Norwalk Air Compressors, actively employed night and day for nearly 18 months for building and exhibition purposes.



TRANSPORTATION BUILDING—EXHIBIT OF THE BUCYRUS STEAM SHOVEL & DREDGE CO., SOUTH MILWAUKEE, WIS.—STEAM SHOVELS, DREDGES, EXCAVATORS, ETC.



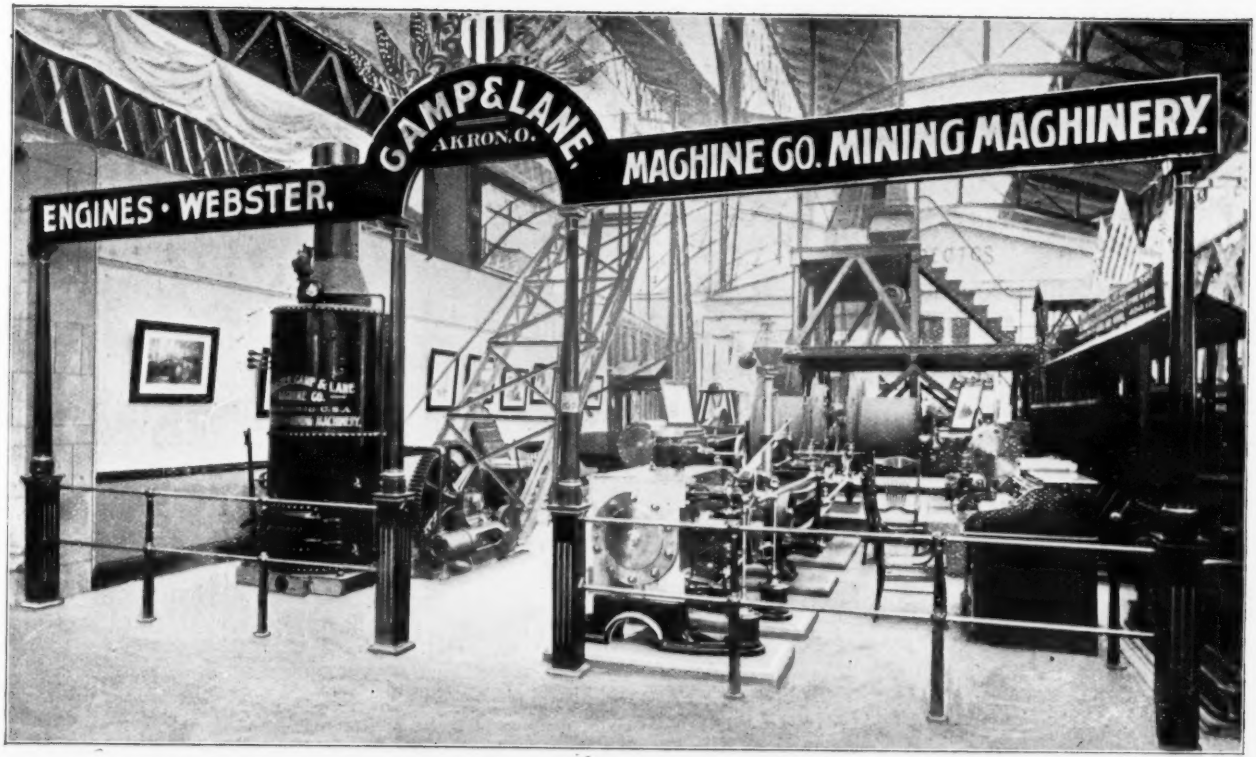
THE BLEICHERT IMPROVED WIRE ROPE TRAMWAY—EXHIBITED BY THE TRENTON IRON CO., TRENTON, N. J.



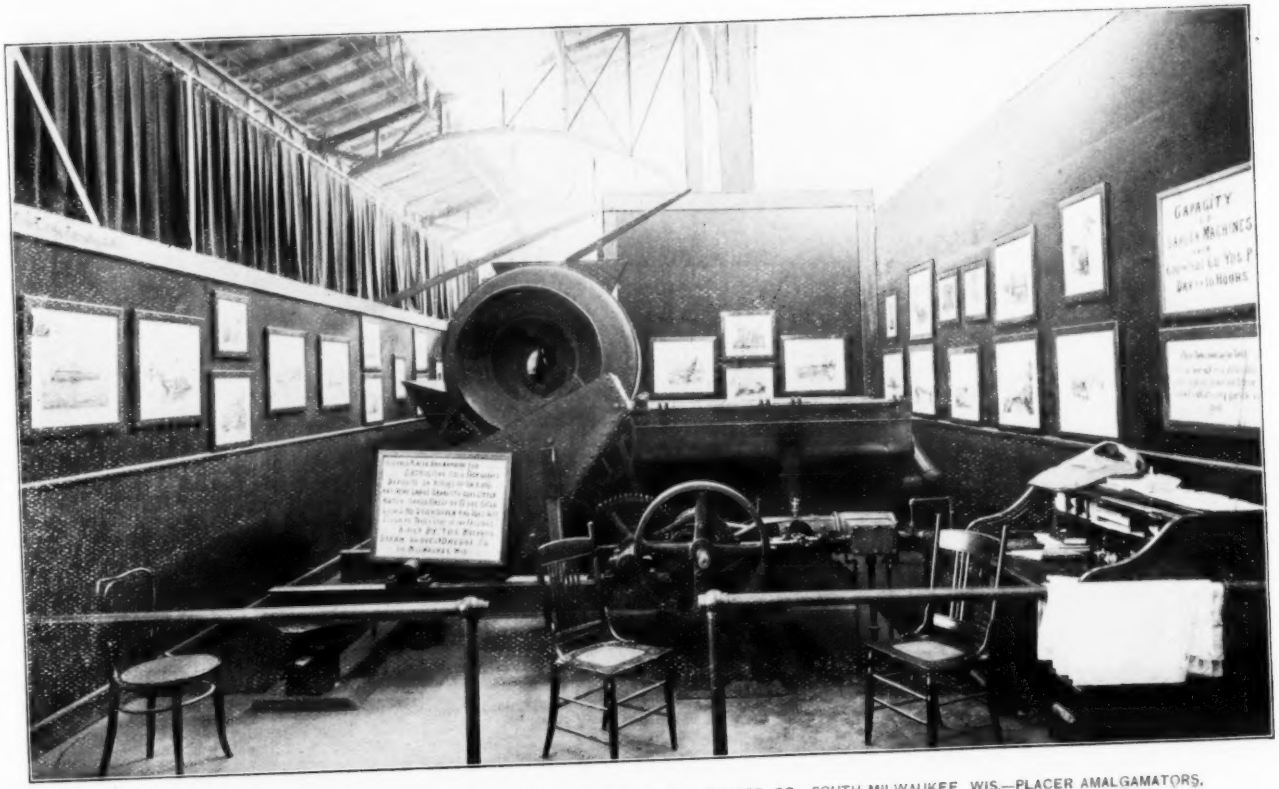
MINES AND MINING BUILDING.—EXHIBIT OF THE JEFFREY M'F'G CO., COLUMBUS, OHIO.—CONVEYING MACHINERY, ELECTRIC COAL CUTTERS, AND MINING MACHINERY.

MINES AND MINING BUILDING—EXHIBIT OF THE INGERSOLL-SERGEANT DRILL CO.—AIR COMPRESSORS, ROCK DRILLS AND GENERAL MINING MACHINERY.

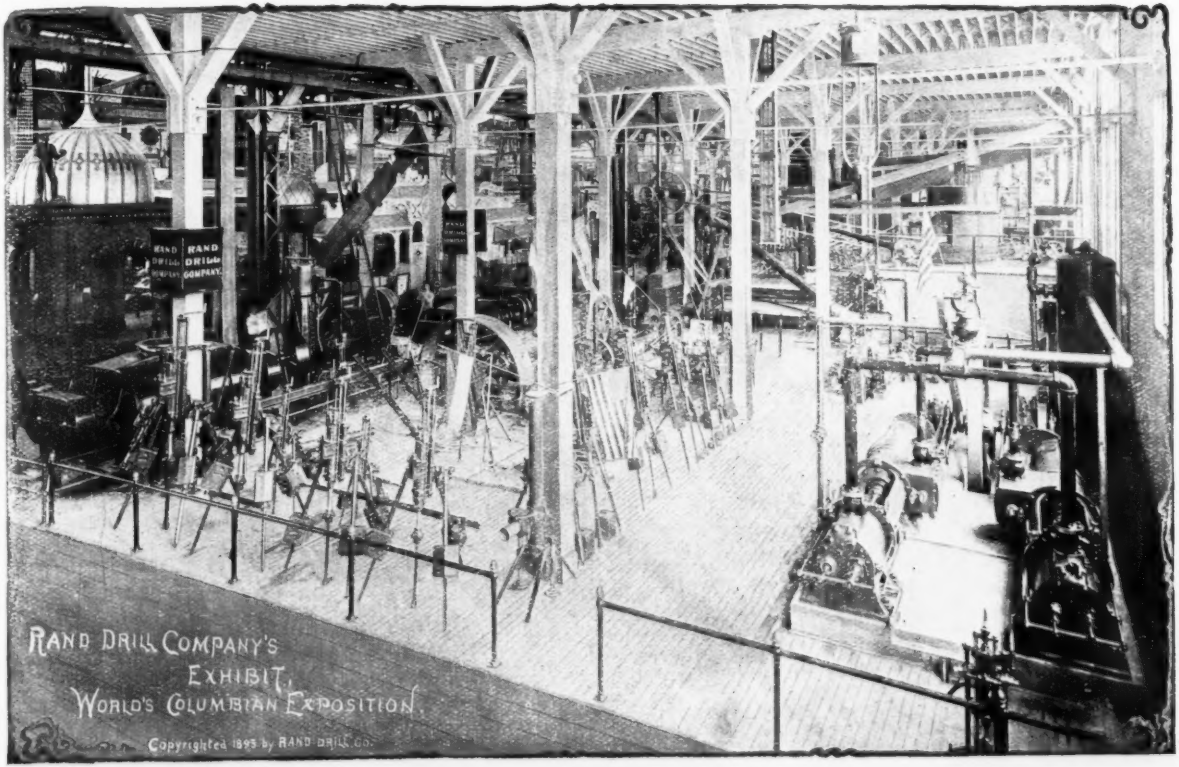
MINES AND MINING BUILDING—EXHIBIT OF THE INGERSOLL-SERGEANT DRILL CO.—AIR COMPRESSORS, ROCK DRILLS AND GENERAL MINING MACHINERY.



MINES AND MINING BUILDING—EXHIBIT OF THE WEBSTER, CAMP & LANE MACHINE CO.—CORLISS ENGINES, HOISTING ENGINES, AND GENERAL MINING MACHINERY.



MINES AND MINING BUILDING—EXHIBIT OF THE BUCYRUS STEAM SHOVEL AND DREDGE CO., SOUTH MILWAUKEE, WIS.—PLACER AMALGAMATORS.



MINES AND MINING BUILDING—EXHIBIT OF THE RAND DRILL CO., NEW YORK—AIR COMPRESSORS, ROCK DRILLS AND GENERAL MINING MACHINERY.

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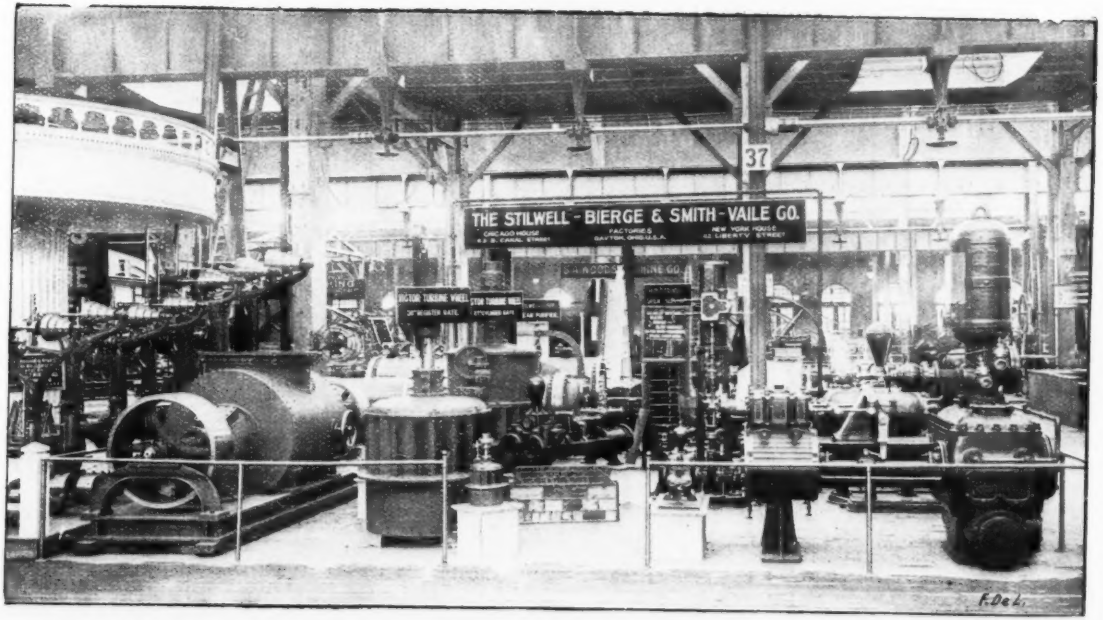
(This entire exhibit was presented by the firm to the Chicago Columbian Museum.)

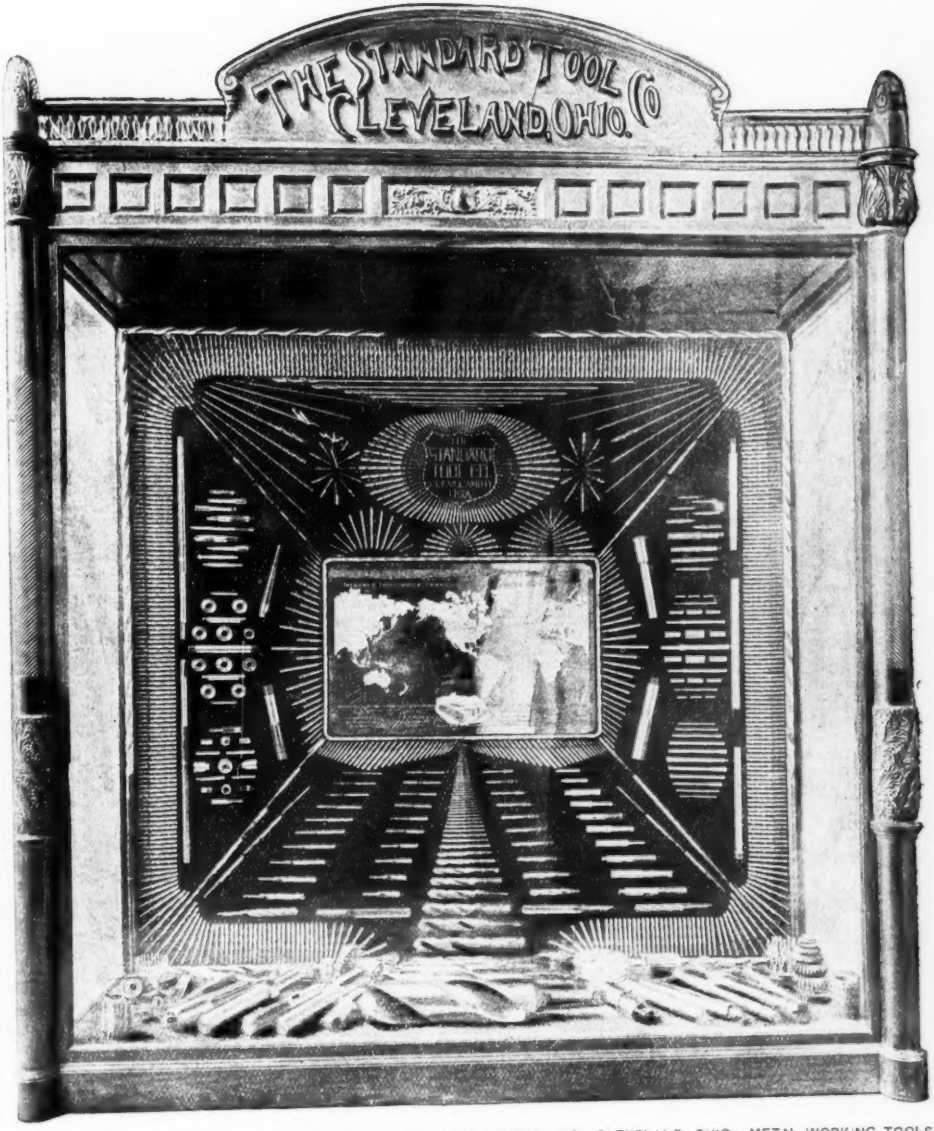


MACHINERY HALL.—EXHIBIT OF THE STILLWELL-BIERCE AND SMITH-VAILE CO., DAYTON, OHIO.—STEAM PUMPS, TURBINE WATER WHEELS, FEED-WATER HEATERS ETC.

MACHINERY HALL.—THE HENRY R. WORTHINGTON EXHIBIT OF PUMPING MACHINERY.

MACHINERY HALL.—EXHIBIT OF THE STILES & PARKER PRESS CO., BROOKLYN, N. Y.—DROP PRESSES, DIES, ETC.

MACHINERY HALL.—EXHIBIT OF THE JOHN H. McGOWAN CO., CINCINNATI, OHIO—PUMP MANUFACTURERS.



MACHINERY HALL.—A PORTION OF THE EXHIBIT OF THE STANDARD TOOL CO., CLEVELAND, OHIO.—METAL WORKING TOOLS.

MACHINERY HALL—EXHIBIT OF THE DIAMOND MACHINE CO., PROVIDENCE, R. I.—GRINDING AND POLISHING MACHINERY.

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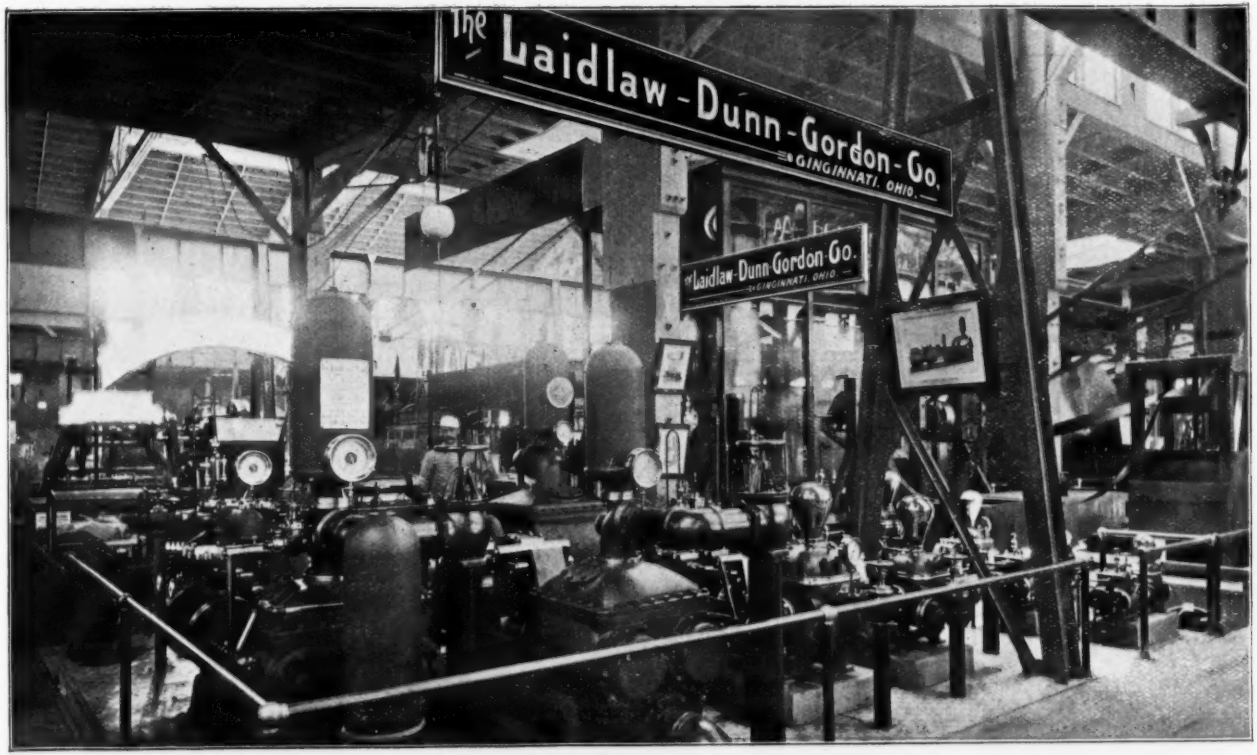
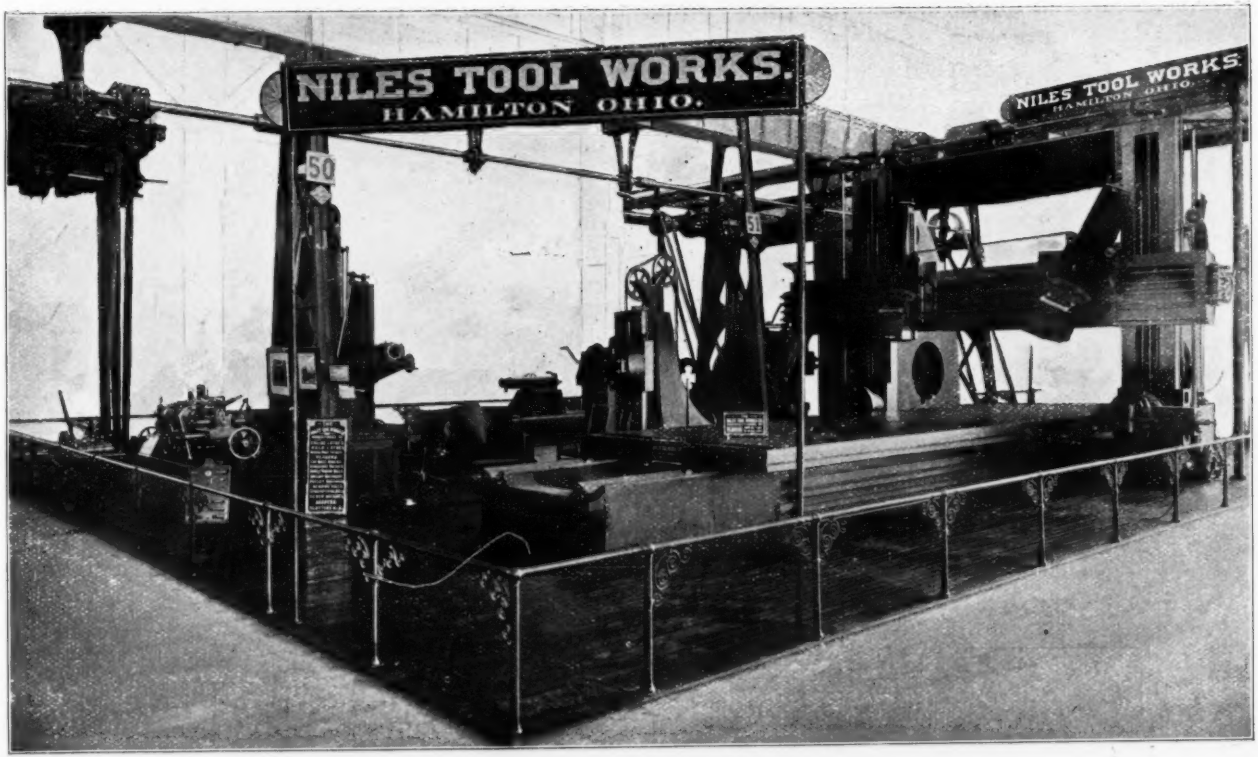
MACHINERY HALL– EXHIBIT OF VOLNEY W. MASON & CO., PROVIDENCE, R. I.—HOISTING MACHINERY AND PULLEYS.

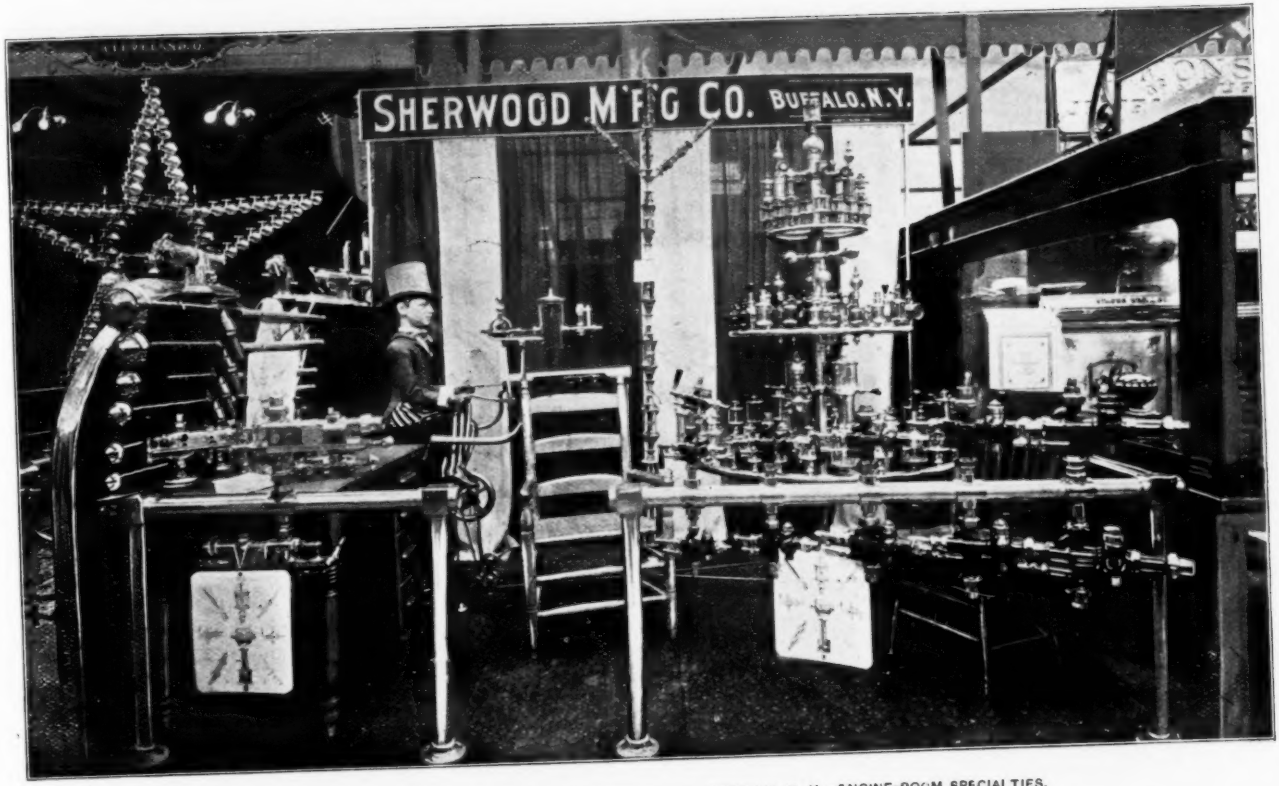


MACHINERY HALL.—EXHIBIT OF THE LAIDLAW-DUNN-GORDON CO., CINCINNATI, OHIO.—PUMPS AND PUMPING MACHINERY.

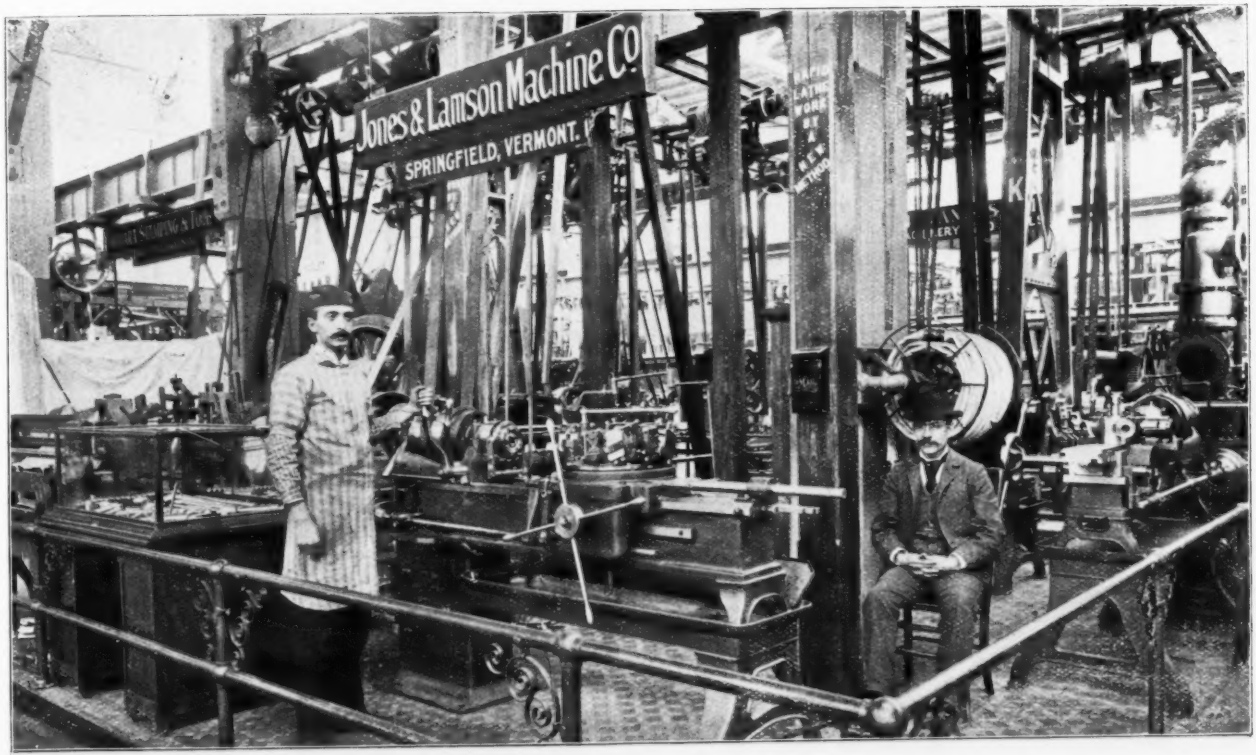
MACHINERY HALL.—EXHIBIT OF THE BILLINGS & SPENCER CO., HARTFORD, CONN.—DROP FORGINGS.



MACHINERY HALL.—EXHIBIT OF THE NILES TOOL WORKS, HAMILTON, OHIO.—MACHINE TOOLS.

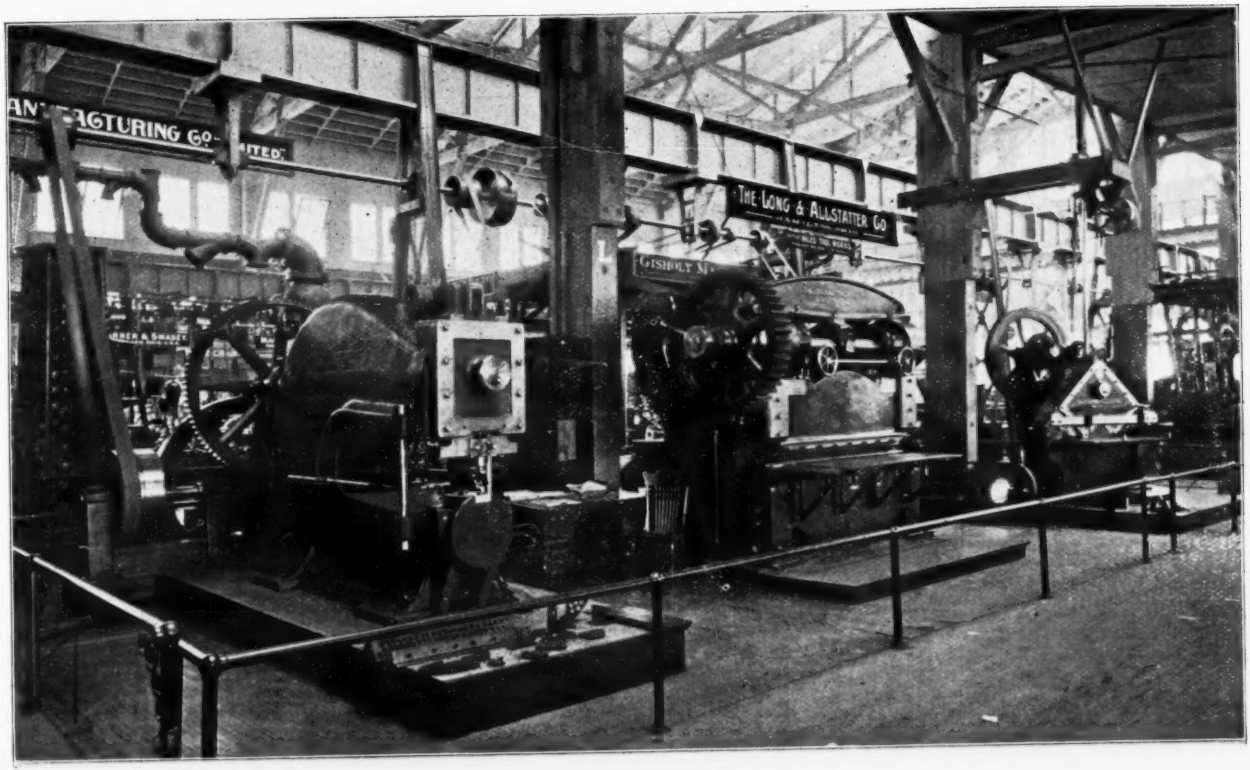


MACHINERY HALL.—EXHIBIT OF THE SHERWOOD MFG. CO., BUFFALO, N. Y.—ENGINE-ROOM SPECIALTIES.

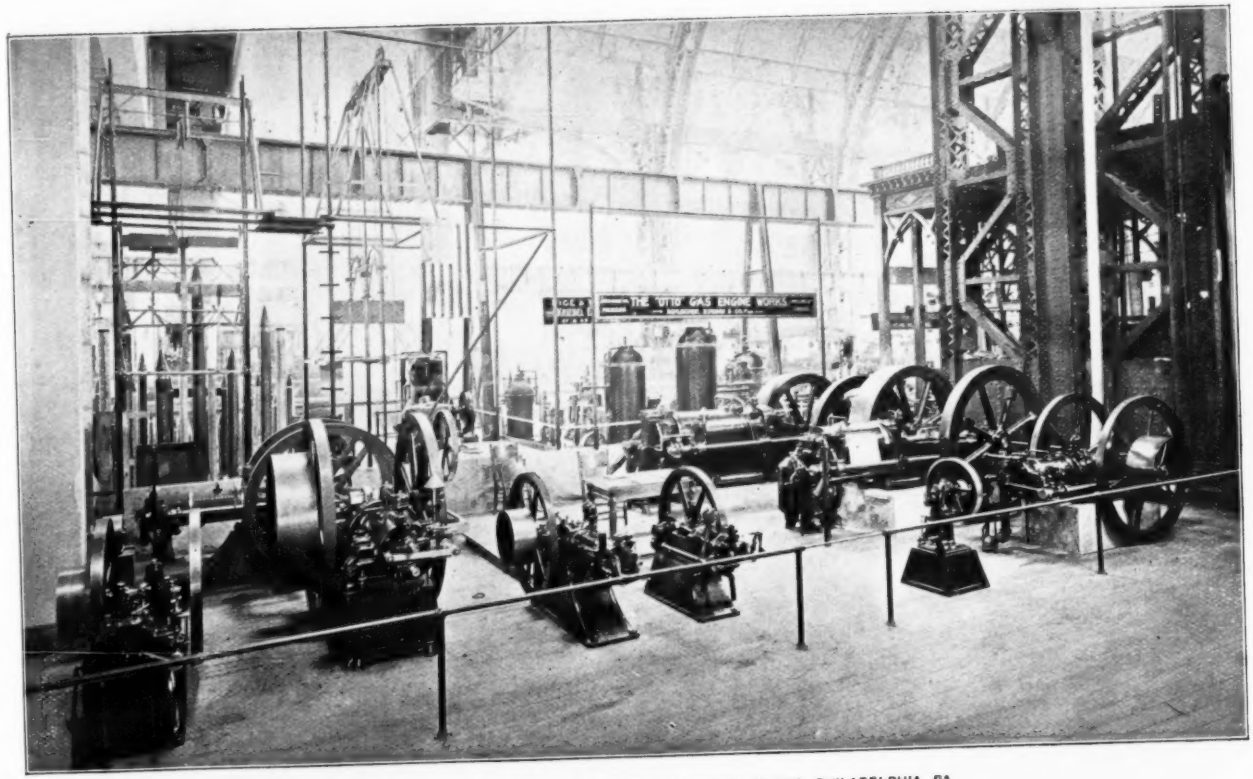


MACHINERY HALL.—EXHIBIT OF THE JONES & LAMSON MACHINE CO., SPRINGFIELD, VT.—MACHINE TOOLS.

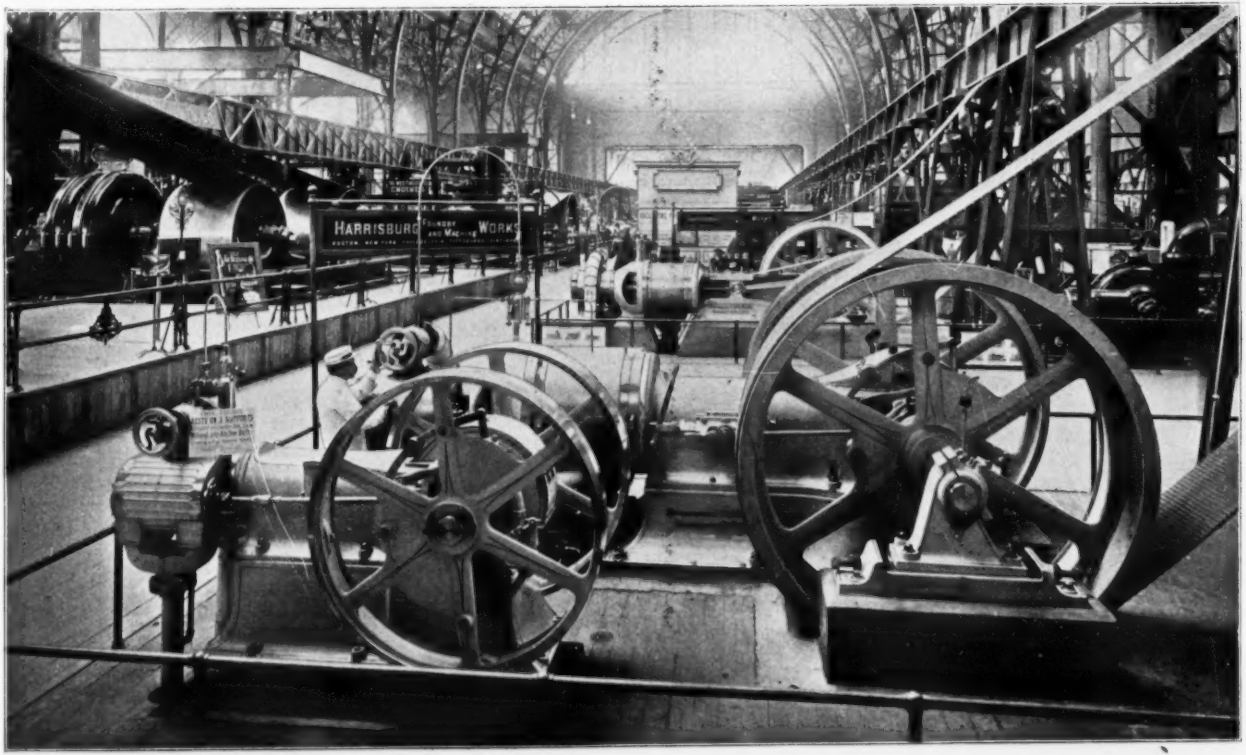
MACHINERY HALL.—EXHIBIT OF THE E. W. BLISS CO., BROOKLYN, N. Y.—DROP PRESSES, DIES, ETC.



MACHINERY HALL.—EXHIBIT OF THE LONG & ALLSTATTER CO., HAMILTON, OHIO.—MACHINE TOOLS.



MACHINERY HALL.—EXHIBIT OF THE OTTO GAS ENGINE WORKS, PHILADELPHIA, PA.



MACHINERY HALL—EXHIBIT OF THE HARRISBURG FOUNDRY AND MACHINE WORKS, HARRISBURGH, PA.—IDE AND IDEAL AUTOMATIC CUT-OFF ENGINES.

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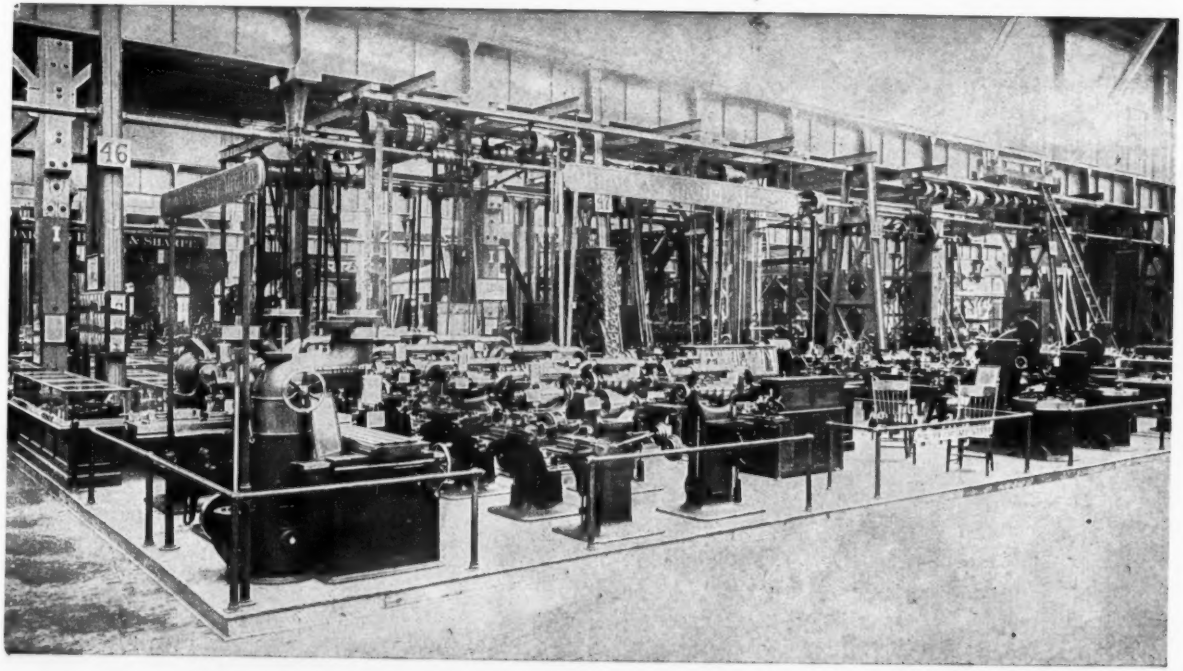
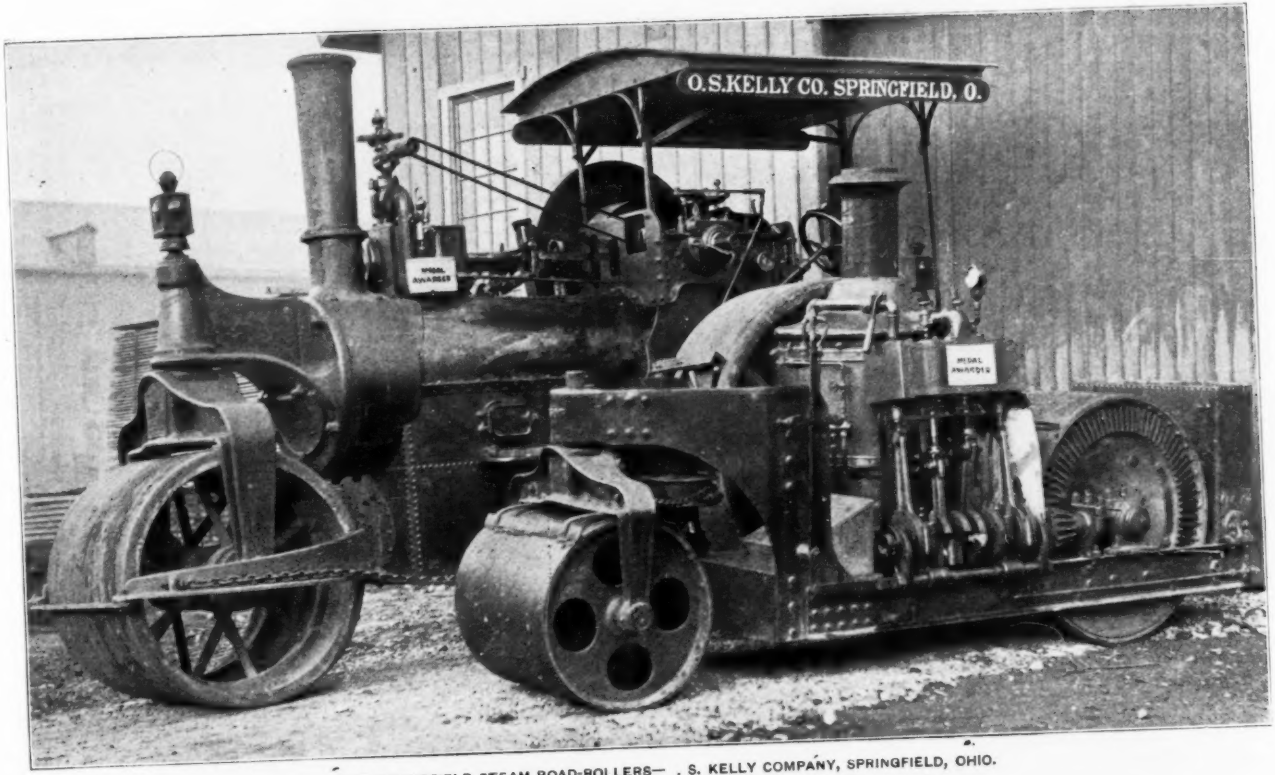


MACHINERY HALL—EXHIBIT OF THE BROWN & SHARPE MFG. CO., PROVIDENCE, R. I.—MACHINE TOOLS.



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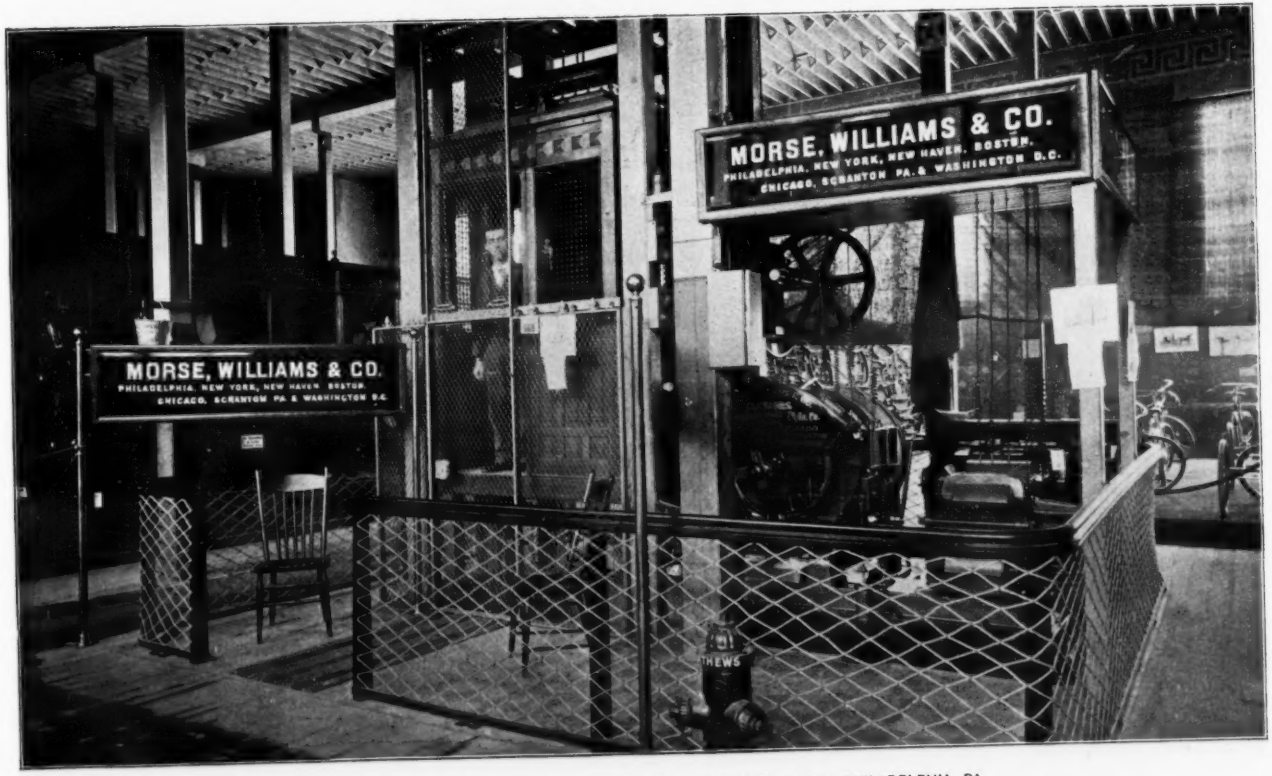
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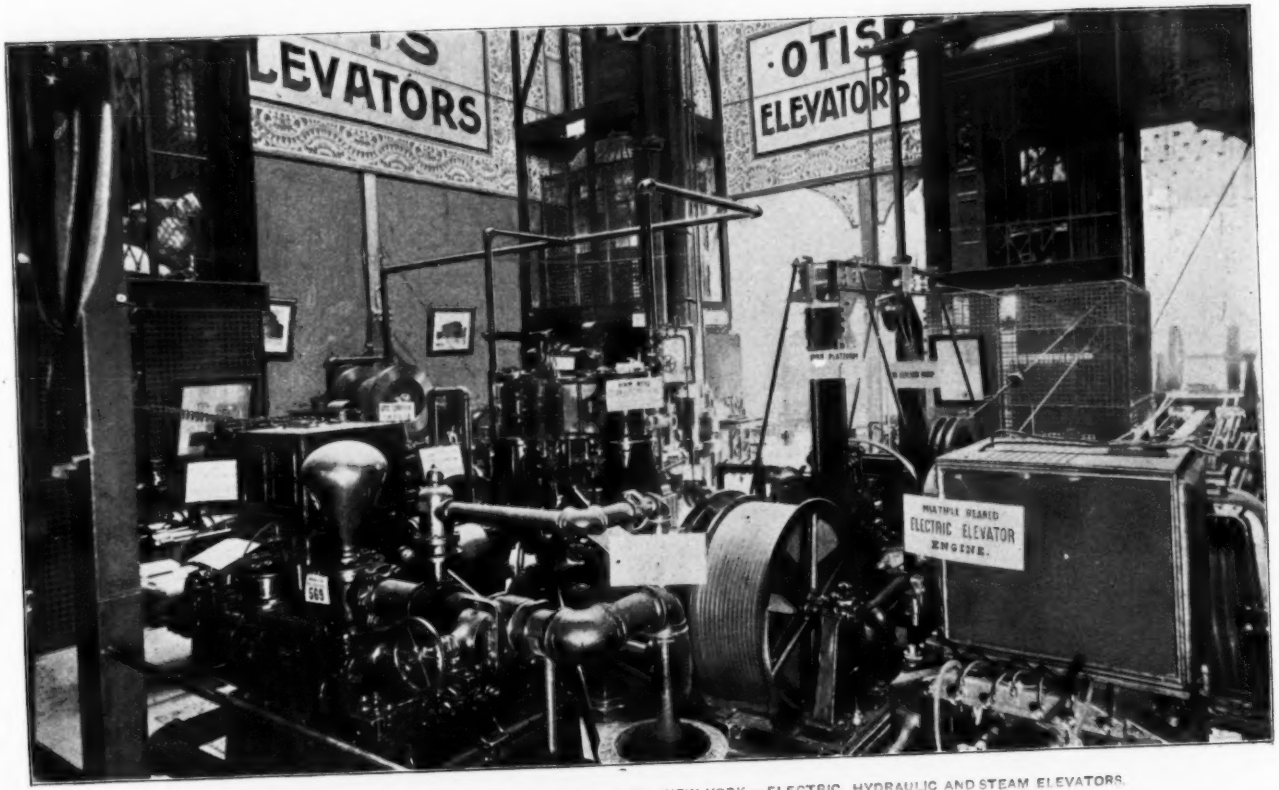

TRANSPORTATION BUILDING—EXHIBIT OF OTIS BROS. & CO., NEW YORK.—ELECTRIC, HYDRAULIC AND STEAM ELEVATORS.

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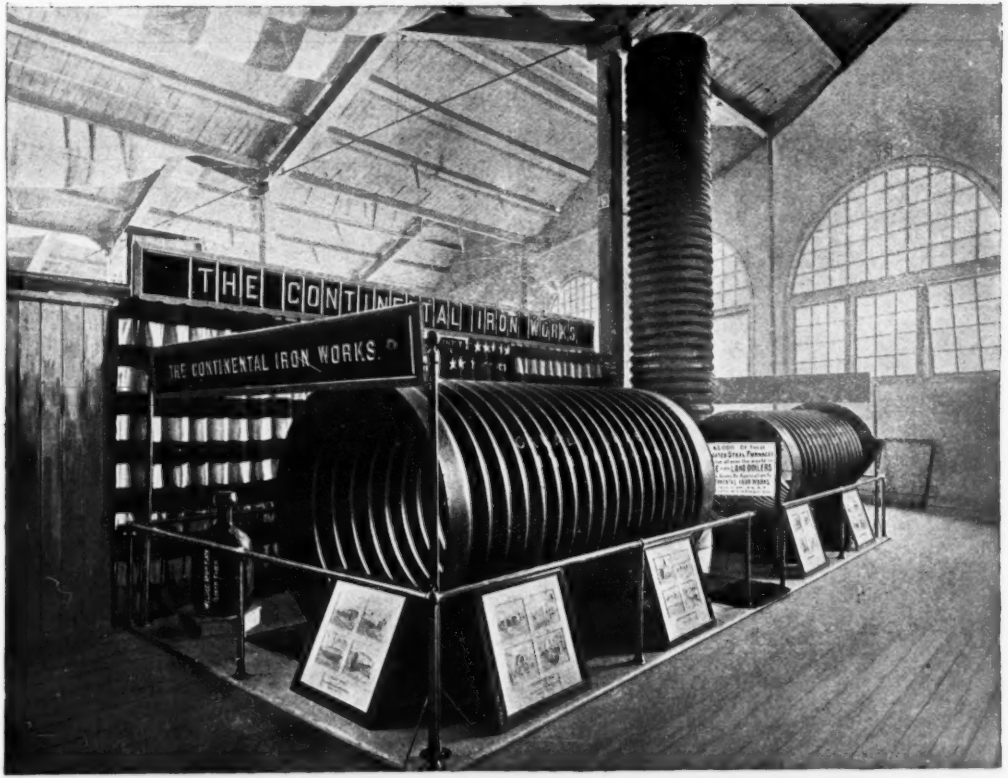

TRANSPORTATION BUILDING—EXHIBIT OF THE CONTINENTAL IRON WORKS, BROOKLYN, N. Y.—CORRUGATED MARINE BOILER FURNACES.

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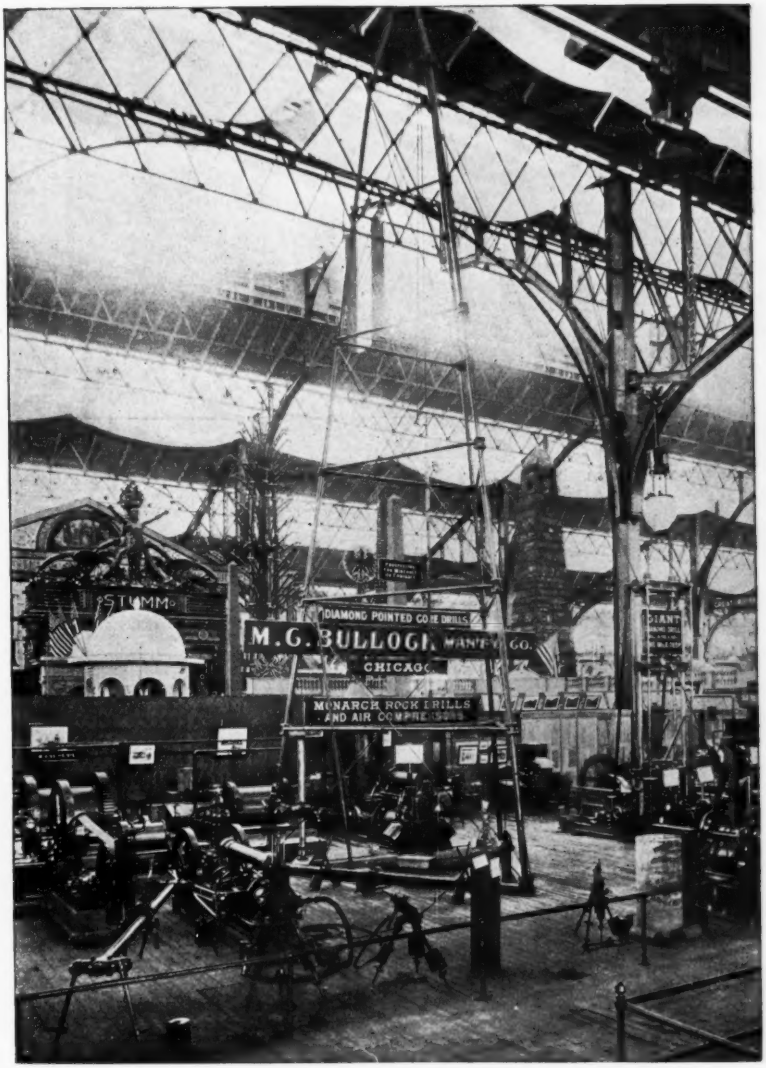
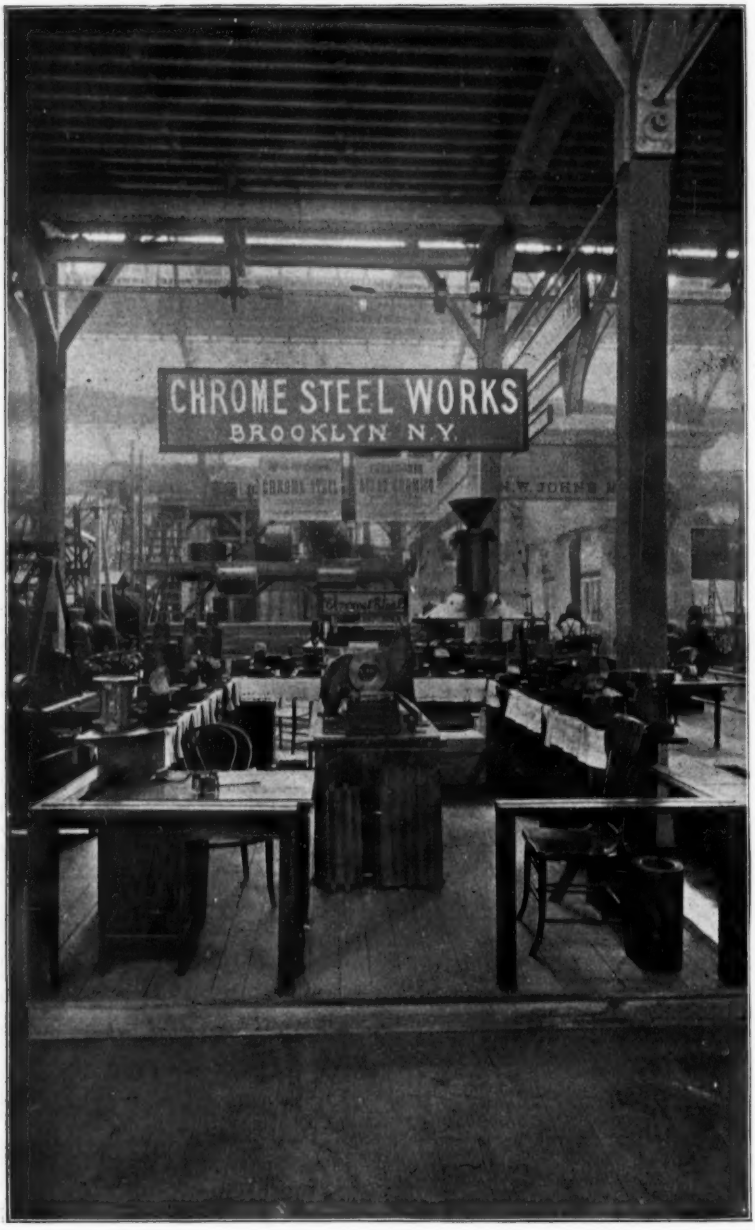
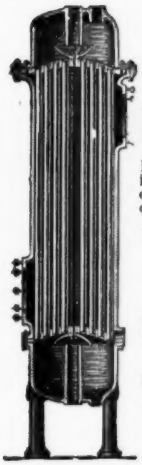


MINES & MINING BUILDING—EXHIBIT OF THE M. C. BULLOCK M'F'G CO., CHICAGO,—ROCK DRILLS, AIR COMPRESSORS, CORLISS ENGINES AND GENERAL MINING MACHINERY.



MINES & MINING BUILDING—EXHIBIT OF THE CHROME STEEL WORKS, BROOKLYN, N. Y.—SHOES AND DIES FOR STAMP MILLS, AND VAULT STEEL.



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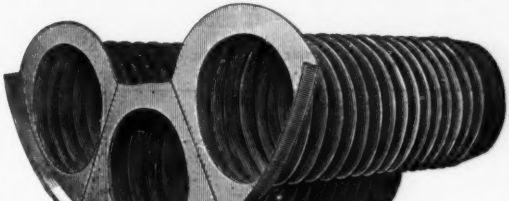

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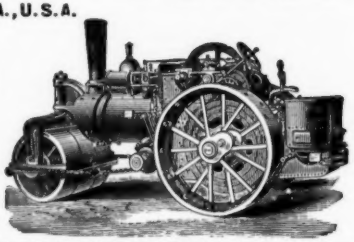

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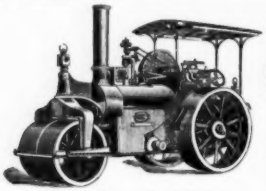

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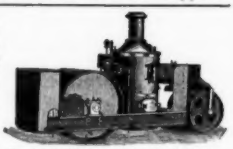

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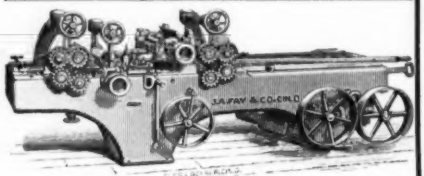

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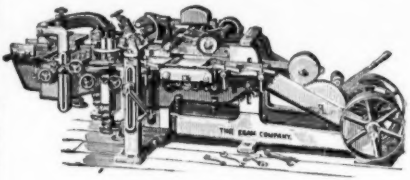

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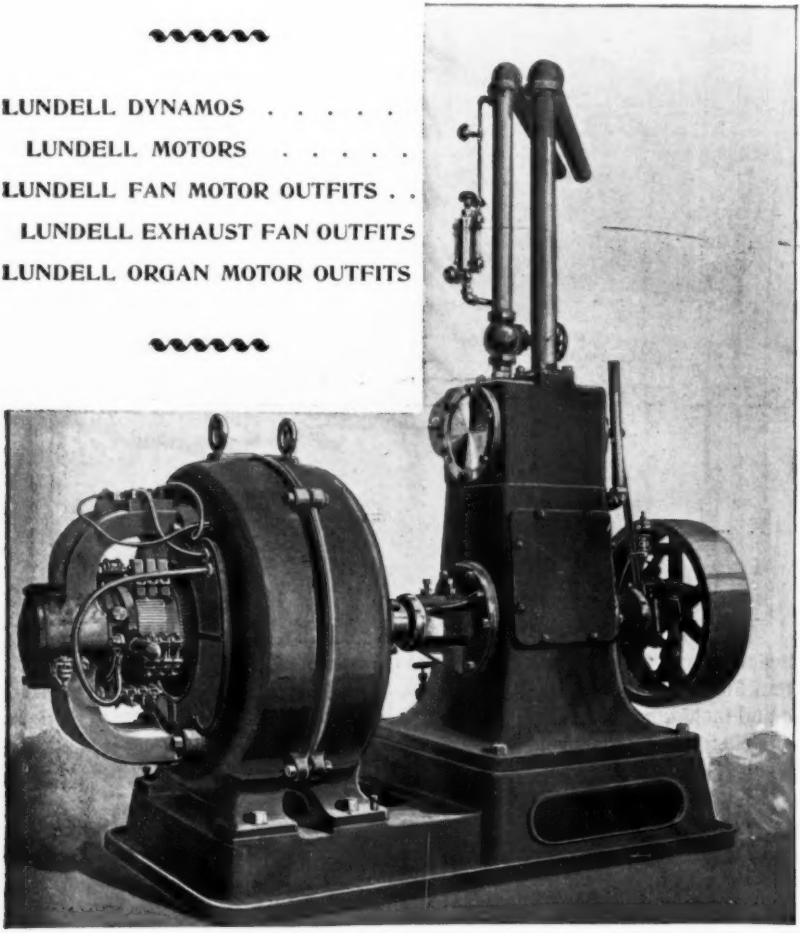

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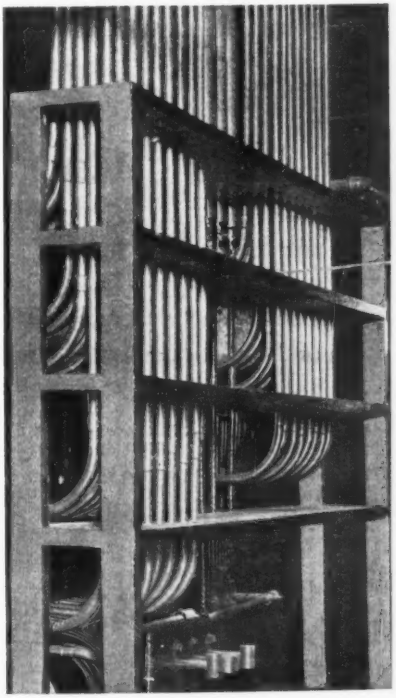

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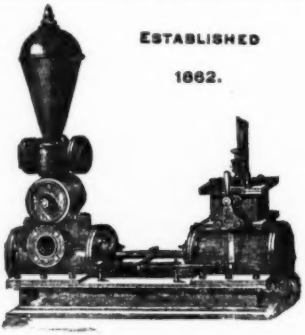

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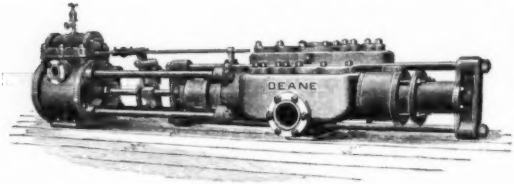

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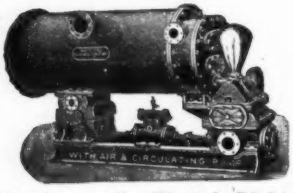

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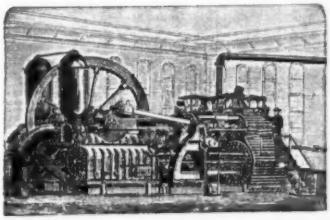

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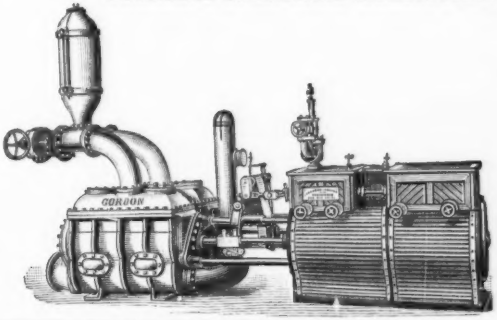

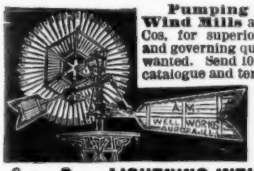

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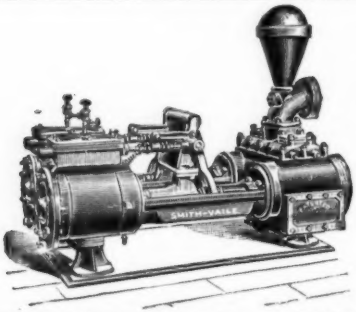

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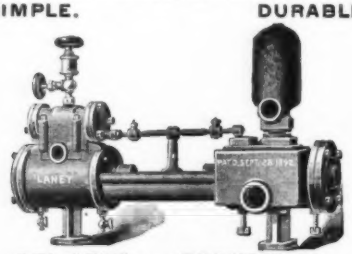

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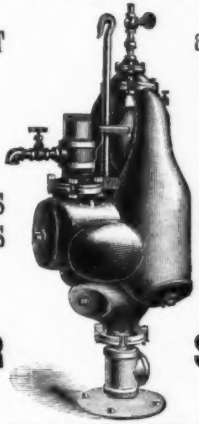

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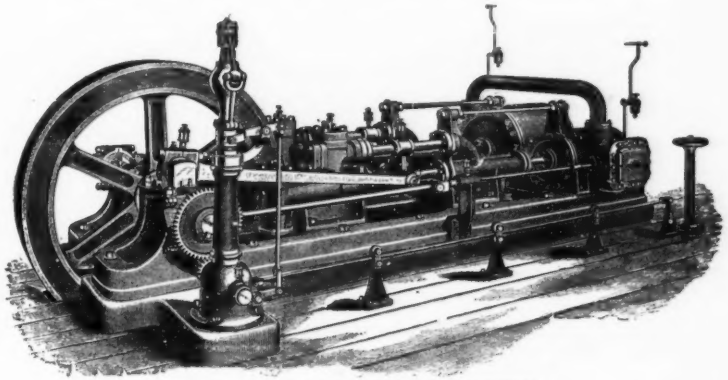

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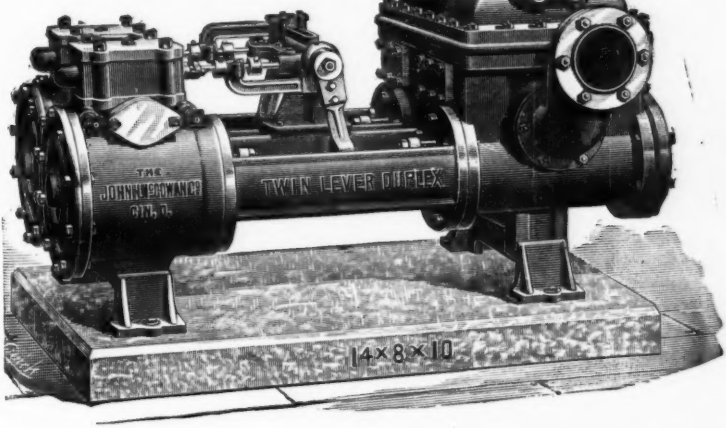

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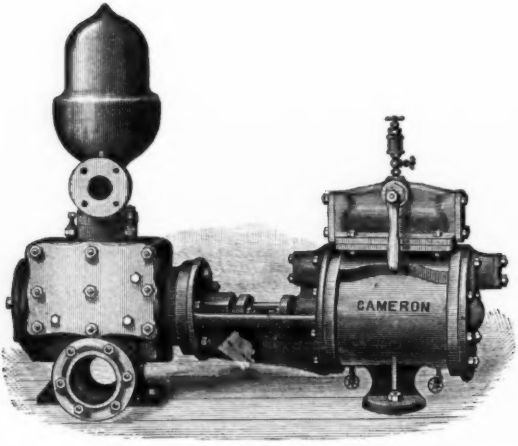

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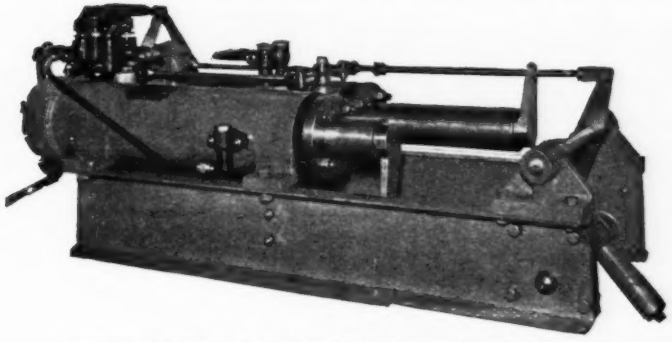

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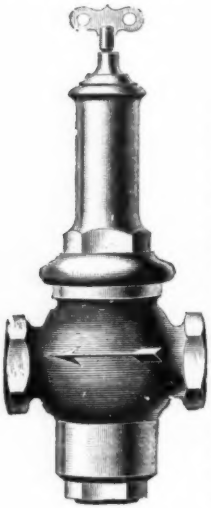

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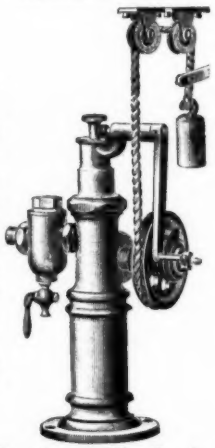

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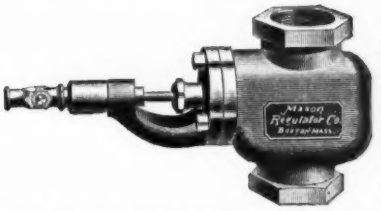

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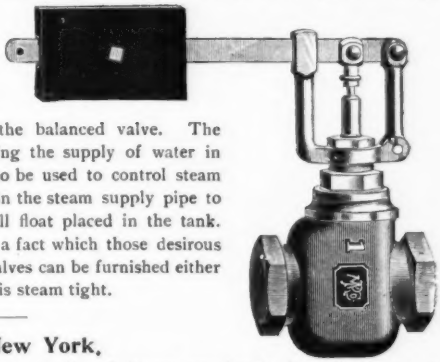

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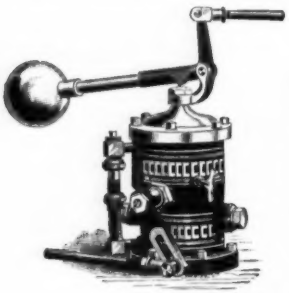


The Mason Pump Governor.

The Mason Pump Governor is to the direct acting steam pump what the ordinary ball governor is to the steam engine. It attaches directly to the piston rod of the pump and operates a balanced valve placed in the steam pipe, thereby exactly weighing the amount of steam to the needs of the pump, and economizing the same. By using the Mason Governor, you can instantly set or change your pump to any required speed, which will be maintained in spite of variation in load or steam pressure. As all the working parts of the governor are immersed in oil, the wear is reduced to a minimum. It is largely used on vacuum pumps, deep well pumps, water works pumps, ice machines, and all classes of pumps requiring an uniform stroke.

Louisiana Sugar Refining Co., New Orleans, La.

The Mason Governors which you furnished for our vacuum pumps, are working to my entire satisfaction, maintaining a uniform speed under the varying conditions of steam pressure, etc. The Mason Reducing Valves, furnished for our Granulators, are also giving excellent results.

Yours truly, GEO. O. EASTWICH, Supt.

The Mason Locomotive Reducing Valve.

This reducing valve has been in use by the leading steam car heating companies for the last five years. During that time over 5000 have been placed on nearly every railroad which has adopted steam heat. One feature which will commend itself to every engineer is the self-locking device, which enables the valve to be set for any pressure, and automatically locked. In the manufacture of this valve there is no attempt made to save on stock in order to cheapen the price. Every valve is made of the best steam metal, and will not steam-cut at a pressure of 180 lbs. As we supply a large number of car-heating and railroad companies, each of whom use different connections, we are prepared to furnish different sizes.

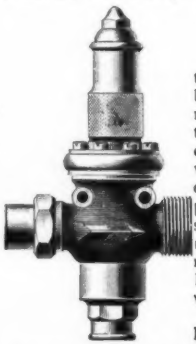
This valve is the standard on 125 railroads.

MASON REGULATOR CO., BOSTON :

Dear Sirs :—I have just put two of your regulators on our passenger engines, and I am very much taken up with them, and like their working.

I am, yours respectfully, OTTO BEST, Nashville, Tenn.

Nashville, Chattanooga & St. Louis Ry.



The Mason Air Brake Pump Regulator.

This is constructed on the same principle as our pump pressure regulator, but with a few small changes, so as to allow of its application to air brake pumps without changing the fittings on the locomotive. It is only necessary to place these in the steam pipe leading to the pump and connect the air pressure pipe with the train service pipe. As the air chamber is entirely separate from the steam and working parts, any particles of dirt which may get into the main service pipe cannot get into the working parts of the regulator and thence into the pump, neither can the steam and air pressure have access to each other. The regulator is fitted with couplings, so that no change in piping will be necessary in substituting it for those now in use. These regulators are the standard on more than thirty railroads. Among those using large quantities we refer to the Pennsylvania, Boston and Albany, Chicago, Rock Island and Pacific, Richmond and Danville, Chesapeake and Ohio, Fitchburg, etc.

We will send one on trial to any railroad. Weight, with couplings, 8½ lbs. Price, $15.00 net.

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Such books free from advertising matter, and charging a reasonable price for same, deserves commendation,

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LA FAYETTE, IND., Jan. 18, 1893.

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SIRS—Enclosed find 55 cents for one copy each of "Key to Engineering," and "Common Sense in Making and Using Steam." Our machine shop has just been burnt to the ground, and the two above copies added to the flames, together with "Rose's Machine Shop Practice." "Rose" will have to wait, but I must have the above works at once. Eagerly awaiting their receipt, I remain,

Very truly yours,

PATERSON, N. J. JAS. H. HOCKING, Engineer.

Send Me Those Three

Books on engineering, as per advertisement. I learn these three small books have more solid information in them than any extant. A friend of mine has a set, and judging from the items he has picked up from them I begin to think I don't know as much as I might about steam engines and "bilers."

JOHN W. CHAPMAN.

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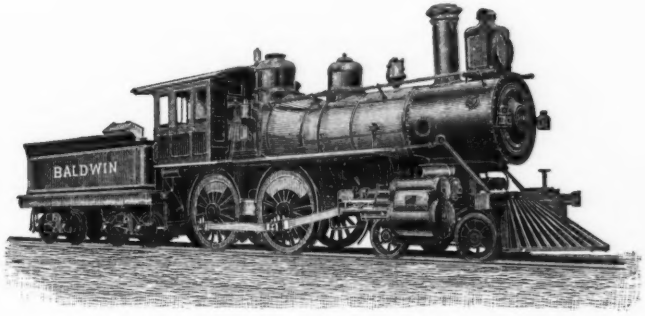

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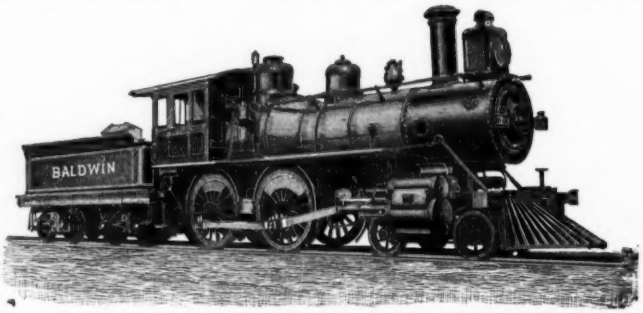

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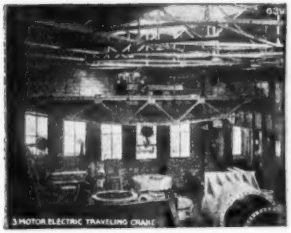

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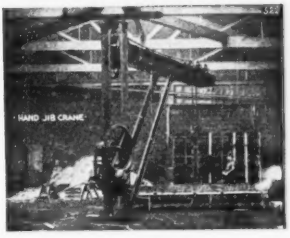

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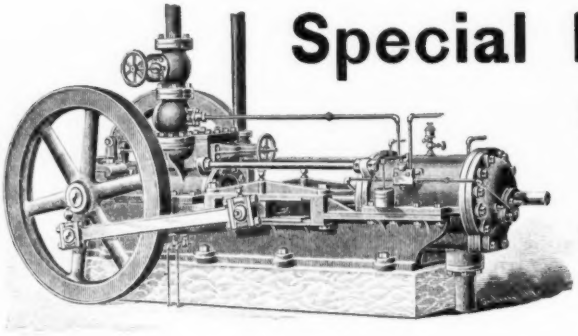

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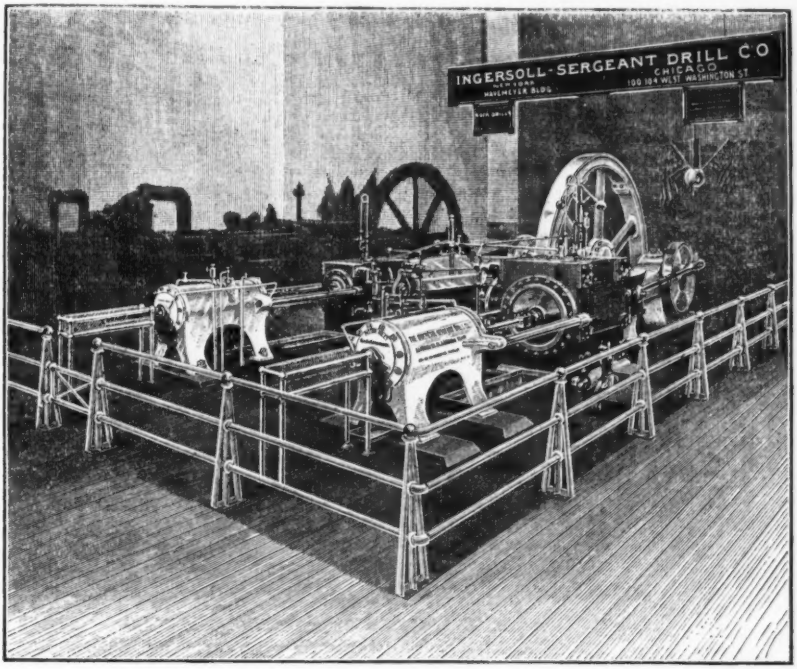

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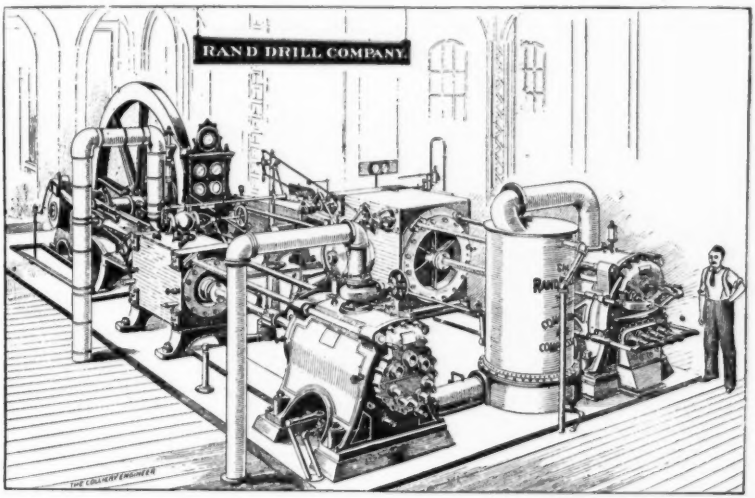

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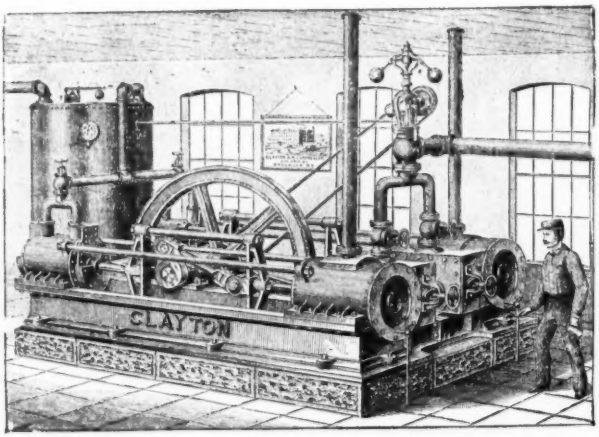

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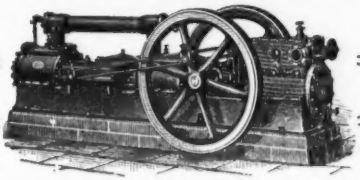

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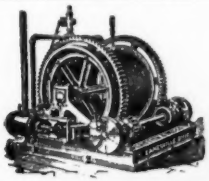

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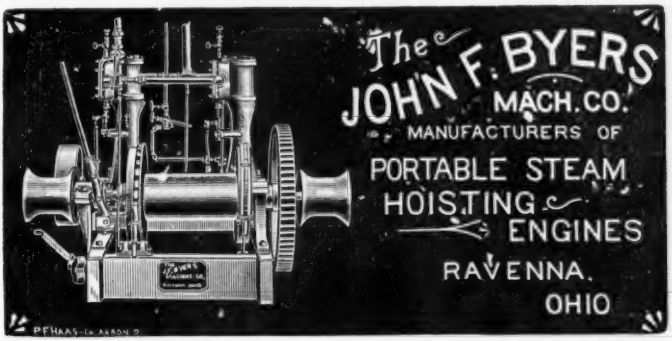

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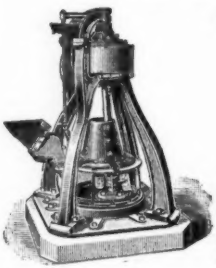

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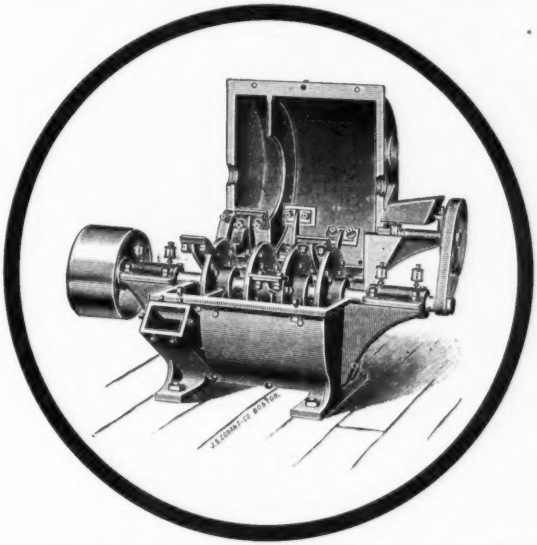

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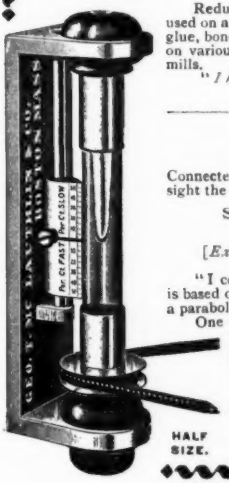

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[Extract from letter of J. G. Henderson, Esq., Engineer in Chief, General Electric Co., N. Y.]

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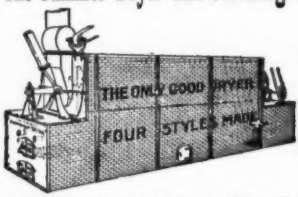

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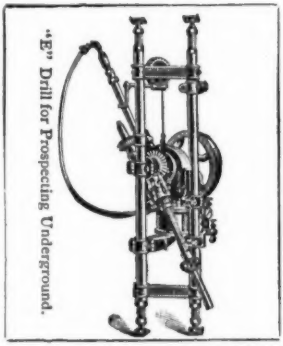

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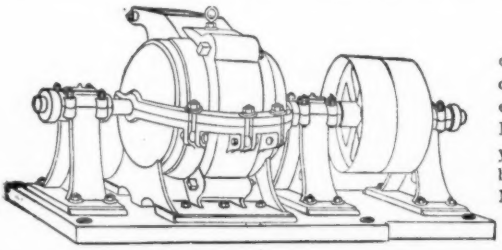

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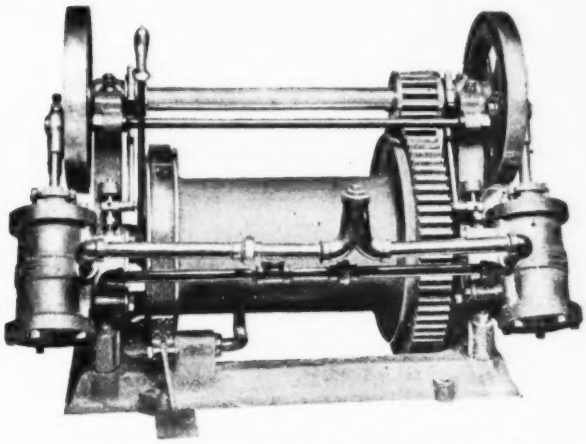

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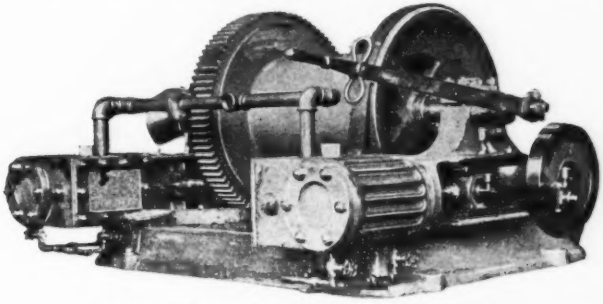

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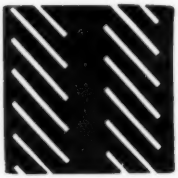
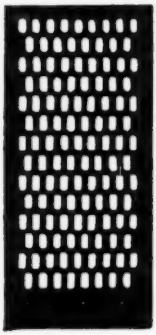
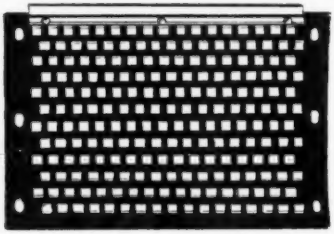


Stamp Battery.

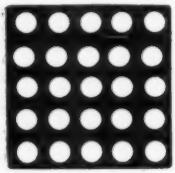
Phosphates.

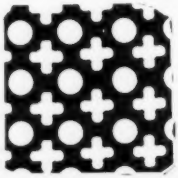


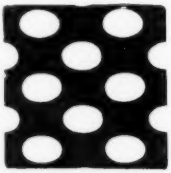
Lip Screen

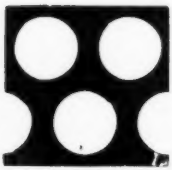


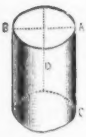
Jacket with Tumbler.

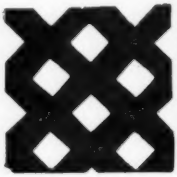


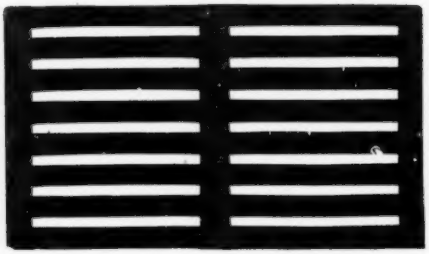












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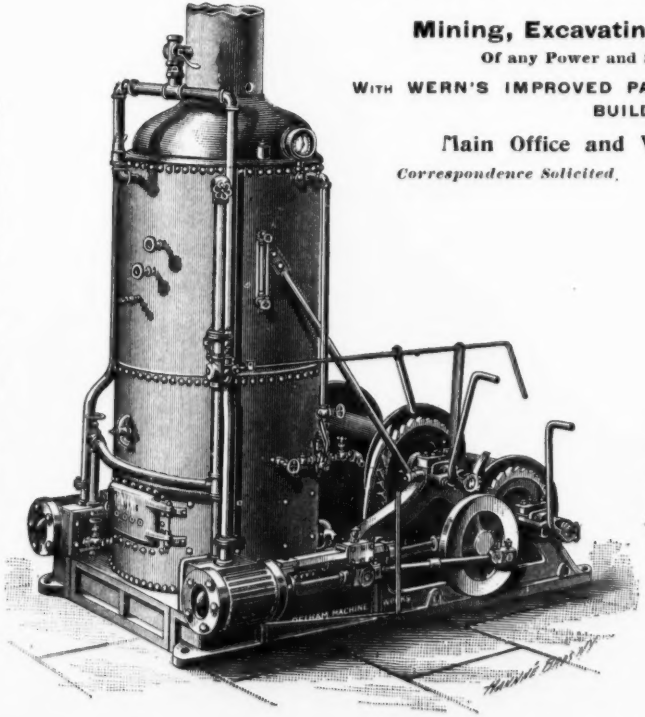

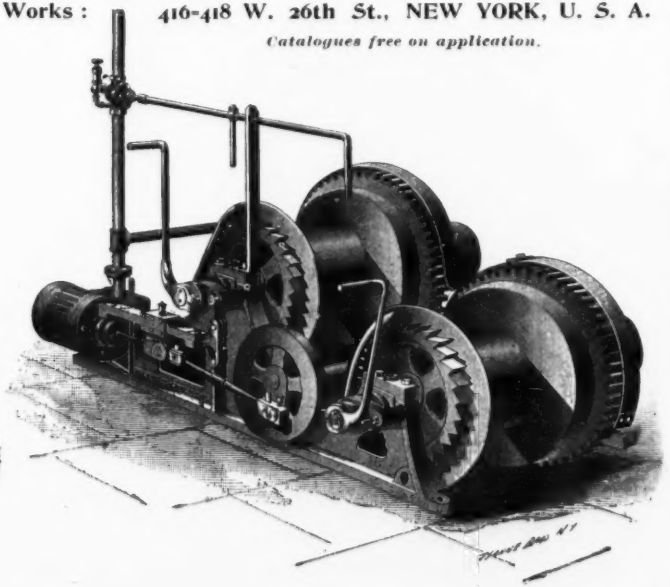

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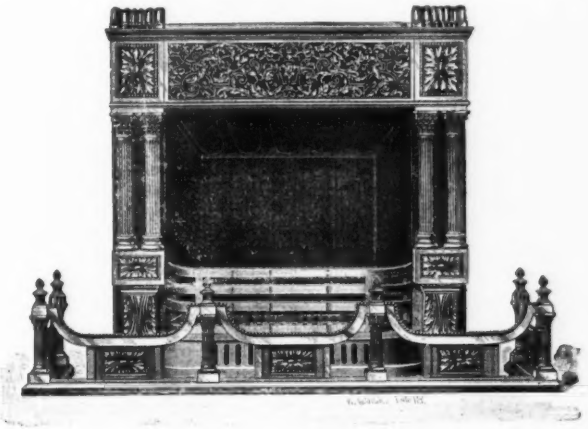

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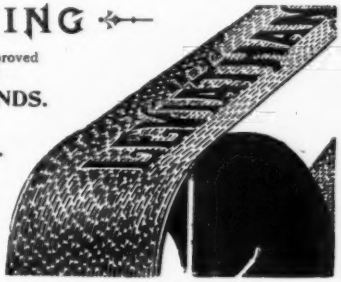

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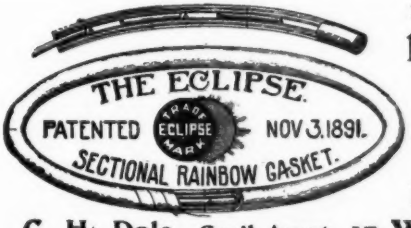

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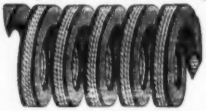

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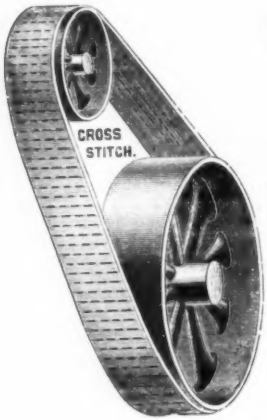

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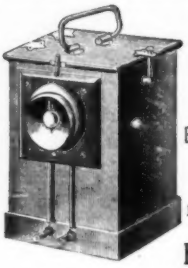

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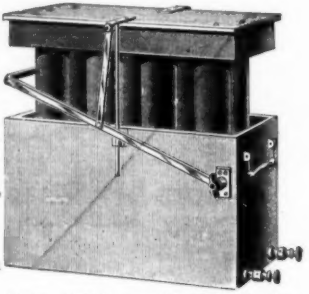

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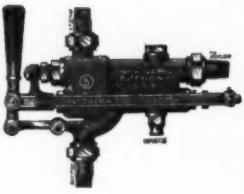

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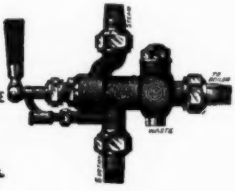

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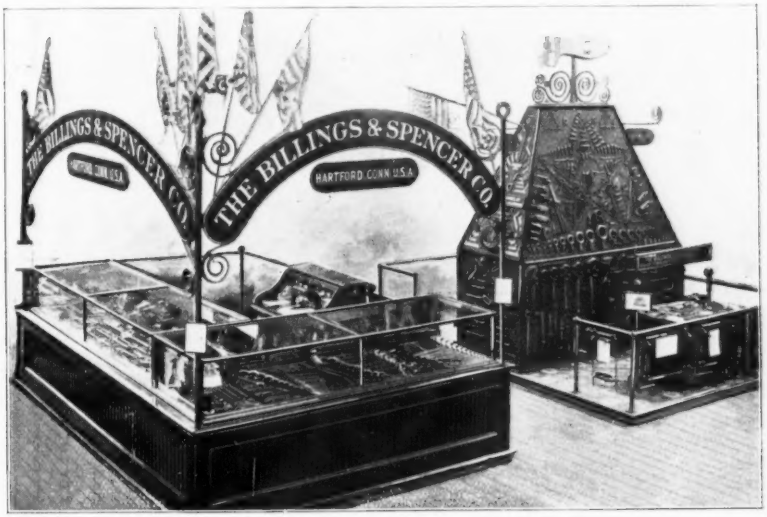

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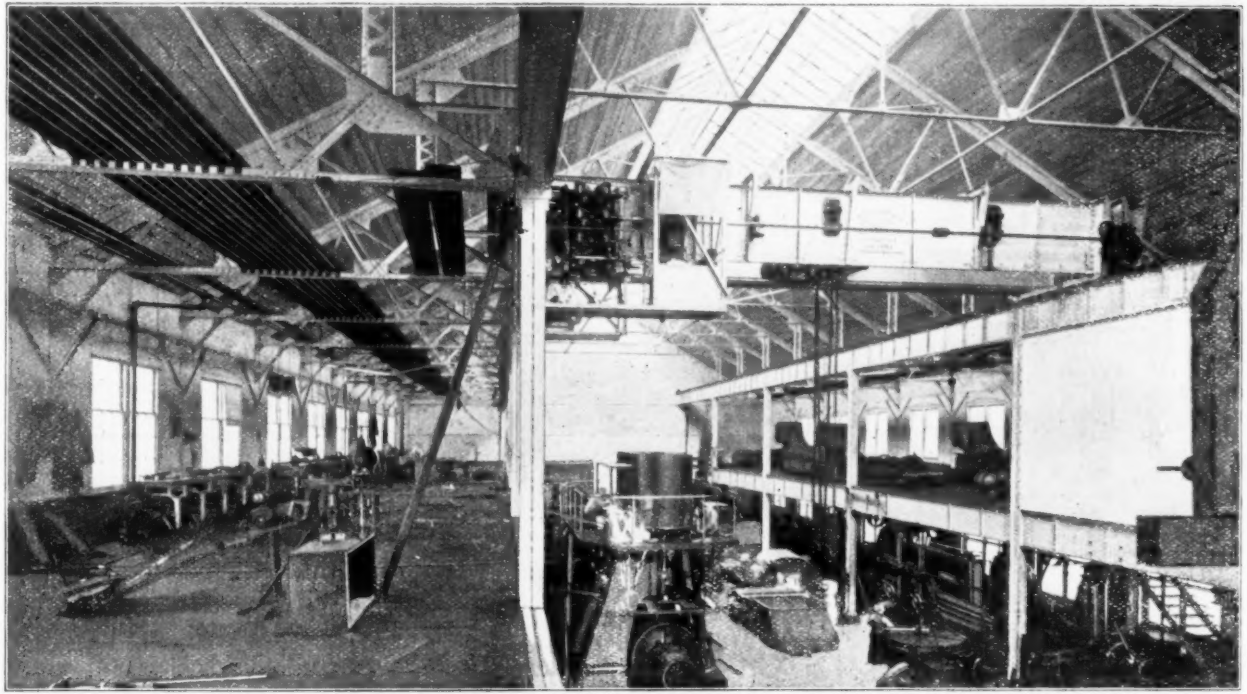

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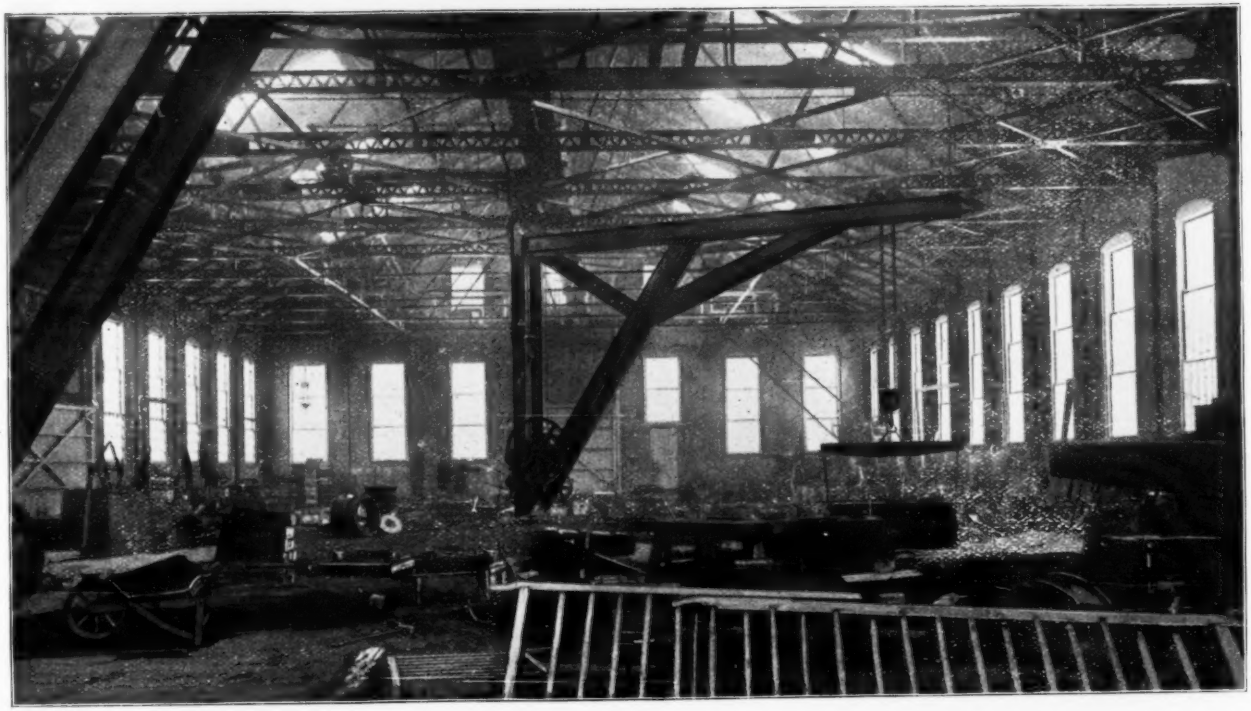
Main Truss Shop of Berlin Iron Bridge Co's. works, East Berlin. Building 80 feet wide and 400 feet long, made of Iron and Glass. Interior lighted by a skylight from roof and glass along sides and ends. Roof designed to carry heavy loads, every roof truss has trolley attached for moving material across the shop. Around each man are heavy overhead travelers for moving the work.



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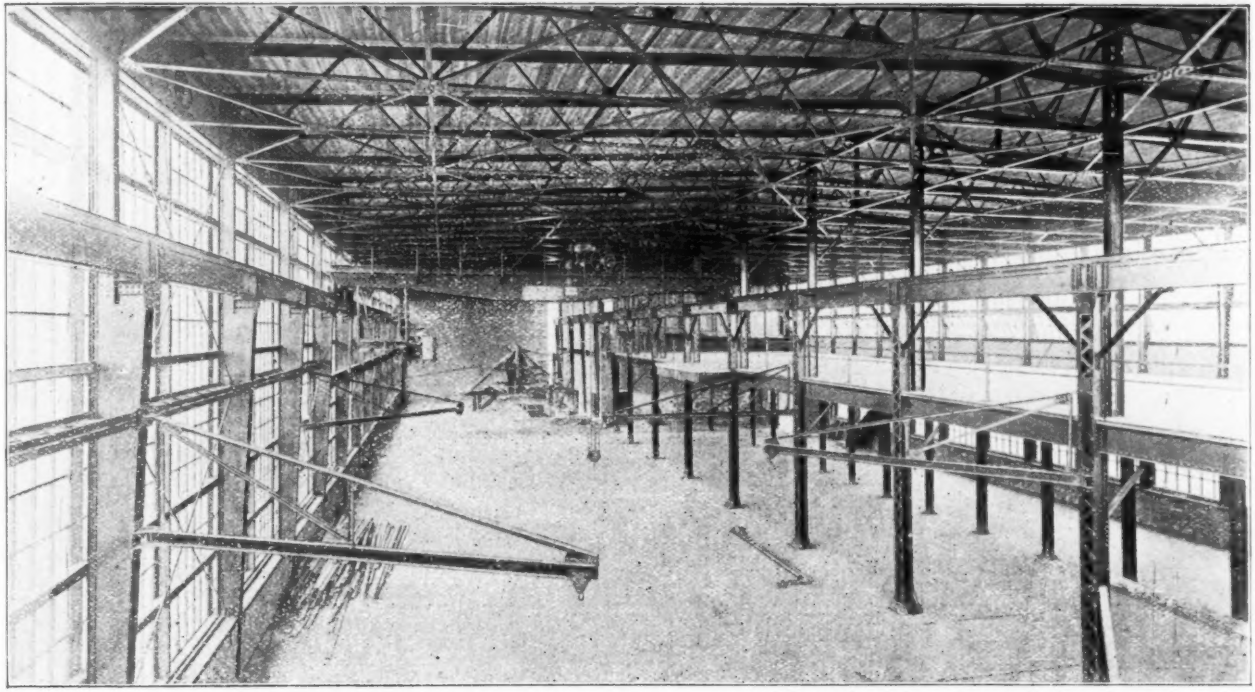
Machine Shop, The Dickson Mfg. Co., Scranton, Penn. Building 100 feet wide and 400 feet long; central portion under the traveling crane 51 feet wide and wings 24 feet 6 inches in width. The interior is lighted by side lights above the traveling crane girders and by a skylight in the roof.



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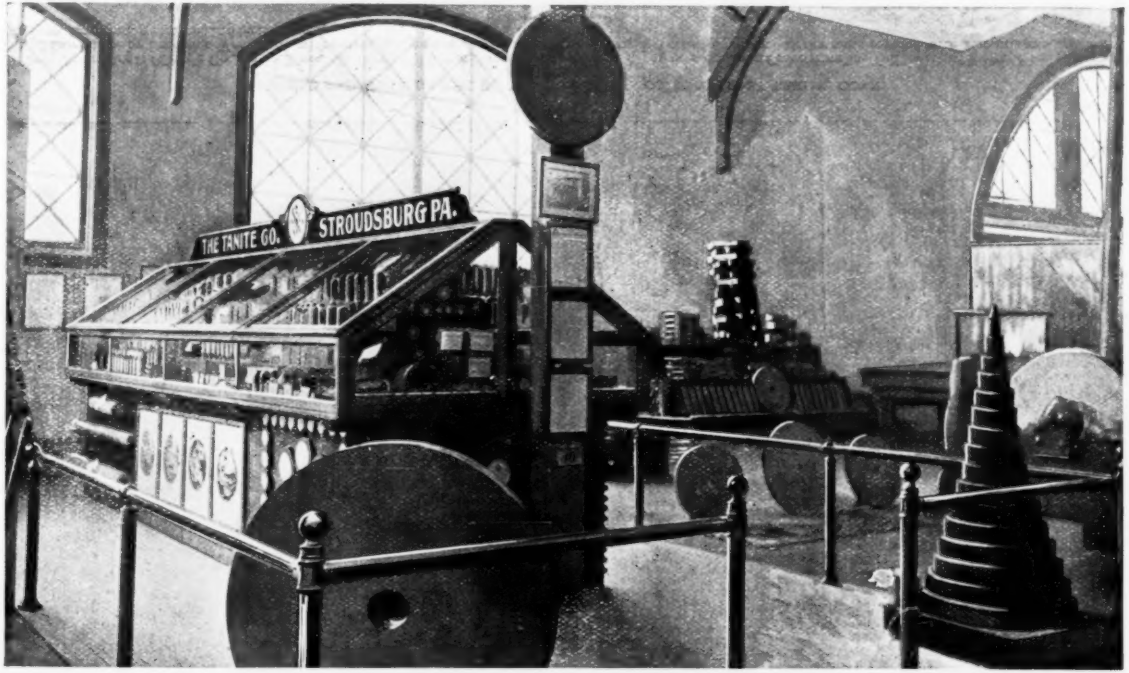

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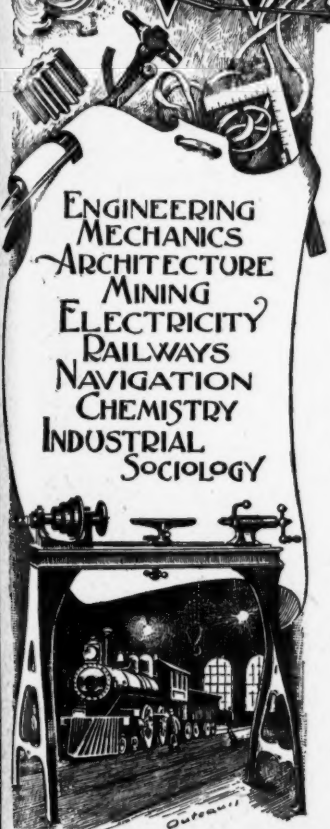

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With Illustrations of Leading Types. WILLIAM LAIRD CLOWES.

How the Ancients Moved Heavy Masses—
Early Illustrations of Mechanical Laws. W. F. DURFEE.

A Plea for Series Electric Traction—
Compared with the Multiple-Arc System. NELSON W. PERRY.

City Water-Supplies of the Future—
Prospective Use of Salt-Water. SAMUEL McELROY.

Florida's Great Phosphate Industry—
Its Relation to American Prosperity. ALFRED ALLEN.

The Proposed Cables Under the Pacific—
"American" and "Imperial" Routes. HERBERT LAWS WEBB.

Precautionary Hints to Inventors—
The Nature of Invention Discussed. FRANK RICHARDS.

American Practice in Silver-Lead Smelting—
A Review of Recent Progress. WALTER RENTON INGALLS.

The Tehuantepec Isthmus Railway—
By the Mexican Minister, SENOR DON MATIAS ROMERO.

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INTRODUCTION TO AUTHORS, PAGE 4.

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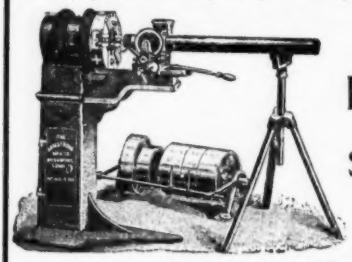

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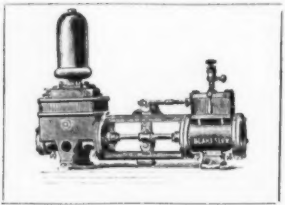

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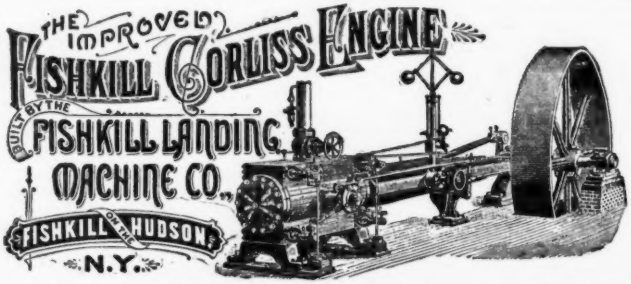

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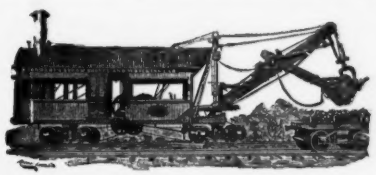

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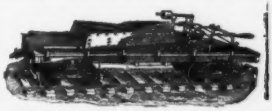

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A WORD OF INTRODUCTION.

AUTHORS AND PAPERS THIS MONTH.

JACQUES HERMANT (*The World's Fair Buildings Through French Spectacles*)=A French architect and son of an architect, both father and son being men of eminence in their profession; also a discriminating art critic; at the head of the delegation of architects sent by the French government to Chicago to erect the buildings representing French interests at the World's Columbian Exposition.

WILLIAM LAIRD CLOWES (*Ships of the New British Navy*)=Born in London, February 1, 1856; educated at King's College, London, of which institution he has since been elected a fellow; has traveled considerably in America and Europe as special correspondent of the *Times* and other London daily papers; has contributed also to the *Engineer*, *Army and Navy Gazette*, *United Service Magazine*, and other English technical and naval periodicals; was a member of the Council and of the General and Arts Committees of the Royal Naval Exhibition (London, 1891); obtained the gold medal of the United States Naval Institute, Annapolis, 1892; is a regular contributor to Lord Brassey's Naval Annual, Whitaker's Almanack, and other works; is a lecturer at the Royal United Service Institution, London.

☞ The illustrations accompanying the paper by Mr. CLOWES have been prepared from an excellent series of photographs by G. WEST & SON, Portsmouth, England.

W. F. DURFEE (*How the Ancients Moved Heavy Masses*)=Born in 1833; has had a large experience as an architect and civil and mechanical engineer; built the first experimental Bessemer steel-works in America and made there the Bessemer steel ingots from which were rolled the first steel rails made on the continent; built the first laboratory used in connection with the manufacture of steel in the United States; is now practicing as a consulting engineer and patent expert; is a contributor to leading technical journals.

NELSON W. PERRY (*A Plea for Series Electric Traction*)=Was graduated as Engineer of Mines, at the School of Mines, Columbia College, in 1878; at once commenced an active career in the profession of mining engineering, which he pursued in the United States and Mexico until 1886. For ten years he was a member of the American Institute of Mining Engineers, and was elected to full membership in the Chemical Societies of Berlin and Paris, and in the American Society of Mechanical Engineers. He has since devoted himself exclusively to electrical engineering. The John Scott Legacy Medal of the Franklin Institute has been awarded to Mr. PERRY for the system described in this paper.

SAMUEL McELROY (*City Water-Supplies of the Future*)=Born at Albany, N. Y., in 1847, of an engineering family; his father, great-uncle, uncle, brother, and son have been or are engineers. Mr. McELROY is the designing engineer of the Brooklyn waterworks; he has a large hydraulic and railway expert practice; has made difficult location surveys in Peru, the Hudson river valley, the Alleghenies, etc.; is an experienced mechanical engineer, and the author of many professional and literary papers.

HERBERT LAWS WEBB (*The Proposed Cables Under the Pacific*)=Began his electrical career as an electrician on board a cable-ship, and served for eight years on various submarine cable expeditions in the Mediterranean, Red Sea, Atlantic and Pacific. He was for some years assistant electrician of the Metropolitan Telephone Co. (New York), resigned to take the editorship of *Electricity*, and is again connected with the former company. The articles on telephony and other electrical subjects contributed by Mr. WEBB to leading technical journals would fill a large volume.

FRANK RICHARDS (*Precautionary Hints to Inventors*)—Born in England; removed to America at the age of ten; became employed in a machine-shop at thirteen, and has since been engaged continuously in mechanical pursuits, having devoted much attention to the construction of models and the perfection of inventions, and also to experiments with compressed air; member of the American Society of Mechanical Engineers; contributor to the technical press.

WALTER RENTON INGALLS, S. B. (*The American Practice in Silver-Lead Smelting*)=Was graduated from the Massachusetts Institute of Technology; has been engaged in mining and metallurgical work in various parts of the United States, Mexico, and Canada; has also visited professionally many of the important mining and smelting districts of Belgium, Germany, and Poland; is the author of the series of papers on ore-dressing and metallurgical machinery in the last edition of "Appleton's Cyclopedia of Mechanics" (1892), and has been a frequent contributor to the technical press, especially the *Engineering and Mining Journal*, of which he was at one time assistant editor.

MATIAS ROMERO (*The Tehuantepec Isthmus Railway*)—Born Oaxaca, Mexico, February 24, 1837; went to Mexico city in 1853 and entered the foreign office; became secretary of the Mexican legation at Washington in 1859 and subsequently chargé d'affaires until 1863; resigned to become chief of staff to General Diaz, returning soon to Washington as minister; in 1868 was appointed minister of finance in Juarez's cabinet; in 1873 retired to the Soconusco district to engage in agriculture and was elected to congress; resumed the treasury portfolio in 1876, was appointed postmaster-general in 1880, was general superintendent in Mexico of the Mexican Southern Railway Co. in 1881–82, and has since, with short intervals, filled the office of Mexican minister at Washington; has published more than fifty volumes, but they are chiefly official reports, relating in part to some of the most difficult questions in the annals of Mexican diplomacy.

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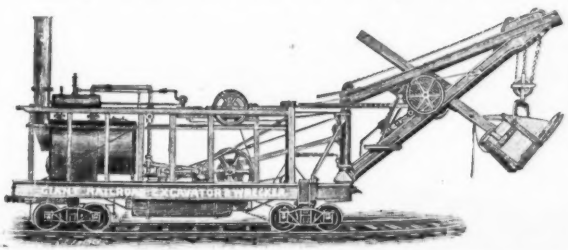

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Edward Darby & Sons, Philadelphia, Pa.
Kinnear & Gager Co., Columbus, Ohio.
Ludlow-Saylor Wire Co., St. Louis, Mo.
Geo. T. McLauthlin & Co., Boston, Mass.
Niles Iron & Steel Roofing Co., Niles, Ohio.
Wrought Iron Bridge Co., Canton, Ohio.
The Continental Iron Works, Brooklyn, N. Y.

Architectural Sheet Metal Work.

Fred F. Bischoff & Co., Chicago, Ill.
Kinnear & Gager Co., Columbus, Ohio.
Niles Iron & Steel Roofing Co., Niles, Ohio.
A. Northrop & Co., Pittsburg, Pa.
Waldo & Stout, Bridgeport, Conn.

Asbestos Mines and Minerals.

A. Leofred, Quebec, Canada.

Balances and Weights.

Henry Troemner, Philadelphia, Pa.

Ballast Unloaders.

Bucyrus Steam Shovel and Dredge Co., S. Milwaukee, Wis.
Marion Steam Shovel Co., Marion, Ohio.

Belt Dressing.

Jos. Dixon Crucible Co., Jersey City, N. J.

Belting.

Boston Woven Hose & Rubber Co., Boston, Mass.
Cooke & Co., 163 Washington St., N. Y.
Home Rubber Co., Trenton, N. J.
Main Belting Co., Philadelphia, Pa.
Peerless Rubber Mfg. Co., 15 Warren St., N. Y.

Blacksmiths' Tools.

Buffalo Forge Co., Buffalo, N. Y.

Blowers.

Buffalo Forge Co., Buffalo, N. Y.
Connersville Blower Co., Connersville, Ind.
Cooke & Co., 163 Washington St., N. Y.
P. H. & F. M. Roots Co., Connersville, Ind.
B. F. Sturtevant Co., Boston, Mass.

Boilers.

Edw. P. Allis Co., Milwaukee, Wis.
Almy Water-Tube Boiler Co., Providence, R. I.
American Well Works, Aurora, Ill.
Atlantic Works, East Boston, Mass.
Cooke & Co., 163 Washington St., N. Y.
Continental Iron Works, Brooklyn, N. Y.
Fairbanks, Morse & Co., Chicago, Ill.
Fishkill Landing Machine Co., Fishkill, N. Y.
Griffith & Wedge Co., Zanesville, Ohio.
Oil Well Supply Co., Pittsburgh, Pa.
Geo. T. McLauthlin & Co., Boston, Mass.
Mundy, J. S. Newark, N. J.
Pelham Machine Works, 416 W. 26th St., N. Y.
Pennsylvania Machine Co., Philadelphia, Pa.
Southwark Foundry and Machine Co., Phila., Pa.
Robt. Wetherill & Co., Chester, Pa.

Boiler Fronts and Fittings.

Vulcan Iron Works, Toledo, Ohio.

Boiler Purifiers.

Wm. Baragwanath & Son, Chicago, Ill.

Boring Machines.

E. W. Bliss Co., Brooklyn, N. Y.
Stiles & Parker Press Co., Brooklyn, N. Y.

Bricks.

Empire Fire-Proofing Co., Pittsburgh, Pa.
Pioneer Fireproof Construction Co., Chicago, Ill.

Bridge Builders.

Berlin Iron Bridge Co., East Berlin, Conn.
Wrought Iron Bridge Co., Canton, Ohio.
The Continental Iron Works, Brooklyn, N. Y.

Brick and Tile Machinery.

F. D. Cummer & Son Co., Cleveland, Ohio.
Frey-Sheckler Co., Bucyrus, Ohio.
Jeffrey Mfg. Co., Columbus, Ohio.
Bucyrus Steam Shovel and Dredge Co., S. Milwaukee, Wis.

Building Materials.

Berlin Iron Bridge Co., East Berlin, Conn.
Fred F. Bischoff & Co., Chicago, Ill.
Central Expanded Metal Co., Pittsburgh, Pa.
Edward Darby & Sons, Philadelphia, Pa.
Joseph Dixon Crucible Co., Jersey City, N. J.
Empire Fire-Proofing Co., Pittsburgh, Pa.
Samuel H. French, & Co., Philadelphia, Pa.
Kinnear & Gager Co., Columbus, Ohio.
Lawrence Cement Co., 67 William St., N. Y.
Ludlow-Saylor Wire Co., St. Louis, Mo.
Geo. T. McLauthlin & Co., Boston, Mass.
Niles Iron & Steel Roofing Co., Niles, Ohio.
A. Northrop & Co., Pittsburg, Pa.
Pioneer Fireproof Construction Co., Chicago, Ill.
Waldo & Stout, Bridgeport, Conn.

Cable Railways.

Robert Poole & Son Co., Baltimore, Md.

Cable Railway Driving Machinery

Edw. P. Allis Co., Milwaukee, Wis.
Lane & Bodley Co., Cincinnati, Ohio.
Robt. Wetherill & Co., Chester, Pa.
Walker Manufacturing Co., Cleveland, Ohio.

Cables, Wire.

Cooper, Hewitt & Co., 17 Burling Slip, N. Y.
John A. Roebling's Sons Co., Trenton, N. J.
Trenton Iron Co., Trenton, N. J.

Cables, Electric and Submarine.

Fred F Bischoff & Co., Chicago, Ill.
Eastern Electric Cable Co., Boston, Mass.
The Okonite Co., Ltd., 13 Park Row, N. Y.

Calcining and Drying Machines.

F. D. Cummer & Son Co., Cleveland, Ohio.

Calipers and Dividers.

J. Stevens Arms & Tool Co., Chicopee Falls, Mass.

Cameras.

Rochester Optical Co., Rochester, N. Y.

Cams and Tappets.

Chrome Steel Works, Brooklyn, N. Y.

Carpenters' Tools.

Bridgeport Gun Implement Co., 317 B'way, N. Y.
J. Stevens Arms & Tool Co., Chicopee Falls, Mass.
E. L. Deane, Holyoke, Mass.

Carriage and Wagon Machinery.

Buffalo Forge Co., Buffalo, N. Y.
Egan Co., Cincinnati, Ohio.
Fox Machine Co., Grand Rapids, Mich.
C. B. Rogers & Co., Norwich, Conn.
Stow Flexible Shaft Co., Ltd., Philadelphia, Pa.
Stow Manufacturing Co., Binghamton, N. Y.

Castings, Iron and Steel.

Addyston Pipe & Steel Co., Cincinnati, Ohio.
Edw. P. Allis Co., Milwaukee, Wis.
Beckett Foundry and Machine Co., Arlington, N. J.
Berlin Iron Bridge Co., East Berlin, Conn.
Buffalo Forge Co., Buffalo, N. Y.
Chester Steel Castings Co., Phila., Pa.
Chrome Steel Works, Brooklyn, N. Y.
Ohio Pipe Co., Columbus, Ohio.
E. Horton & Son Co., Windsor Locks, Conn.
Lane & Bodley Co., Cincinnati, Ohio.
Robert Poole & Son Co., Baltimore, Md.
Pratt & Letchworth, Buffalo, N. Y.
Standard Steel Casting Co., Thurlow, Pa.
Walburn Swenson Co., Chicago, Ill.
Walker Manufacturing Co., Cleveland, Ohio.
Wheeler Condenser and Eng. Co., 92 Liberty St., N.Y.
R. D. Wood & Co., Philadelphia, Pa.

Cement.

Lawrence Cement Co., 67 William St., N. Y.

Chain Belting.

Jeffrey Mfg. Co., Columbus, Ohio.
Link Belt Engineering Co., Phila., Pa.
F. H. C. Mey Chain Belting Eng. Works, Buffalo, N.Y.
Walburn-Swenson Co., Chicago, Ill.

Chemical Works Machinery.

Walburn-Swenson Co., Chicago, Ill.
R. D. Wood & Co., Philadelphia, Pa.

Chucks (All Purposes).

Cushman Chuck Co., Hartford, Conn.
E. Horton & Son Co., Windsor Locks, Conn.
Morse Twist Drill & Machine Co., New Bedford, Mass.
Standard Tool Co., Cleveland, Ohio.
D. E. Whiton Machine Co., New London, Conn.

Clay Working Machinery.

Bucyrus Steam Shovel and Dredge Co., S. Milwaukee, Wis.
F. D. Cummer & Son Co., Cleveland, Ohio.
Jeffrey Mfg. Co., Columbus, Ohio.
Vulcan Iron Works, Toledo, Ohio.

Clutches, Friction.

John F. Byers Machine Co., Ravenna, Ohio.
J. H. & D. Lake Co., Massillon, Ohio.
Volney W. Mason & Co., Providence, R. I.
Moore & White Co., Philadelphia, Pa.
J. S. Mundy, Newark, N. J.
Pelham Machine Works 416 W. 26th St., N. Y.
J. W. Penfield & Son, Willoughby, Ohio.
Robert Poole & Son Co., Baltimore, Md.
Walker Manufacturing Co., Cleveland, Ohio.

Coal Mining Machinery.

Beckett Foundry & Machine Co., Arlington, N. J
A. J. Beckley & Co. Meriden, Conn.
Buffalo Forge Co., Buffalo, N. Y.
General Electric Co., 44 Broad St., N. Y.
Griffith & Wedge Co., Zanesville, Ohio.
C. W. Hunt, Co., 45 Broadway, N. Y.
Ingersoll-Sergeant Drill Co., 10 Park Pl., N.Y.
Jeffrey Mfg. Co., Columbus, Ohio.
Lane & Bodley Co., Cincinnati, Ohio.
Rand Drill Co., 23 Park Place, N. Y.
Sullivan Machinery Co., Chicago, Ill.
Walburn-Swenson Co., Chicago, Ill.
Waldo & Stout, Bridgeport, Conn.

Concentrators and Pulverizers.

Bradley Fertilizer Co., Boston, Mass.
F. D. Cummer & Son Co., Cleveland, Ohio.
Frisbee-Lucop Mill Co., 145 Broadway, N. Y.
Beckett Foundry and Machine Co., Arlington, N. J.
Gates Iron Works, Chicago, Ill.
Lane & Bodley Co., Cincinnati, Ohio.
Geo. T. McLauthlin & Co., Boston, Mass.
Sturtevant Mill Co., Boston, Mass.
Walburn-Swenson Co., Chicago, Ill.

Condensers, Jet.

Deane Steam Pump Co., Holyoke, Mass.
Lane & Bodley Co., Cincinnati, Ohio.
Wheeler Condenser and Eng. Co., 92 Liberty St., N.Y.

Condensers, Surface.

Edw. P. Allis Co., Milwaukee, Wis.
Wm. Baragwanath & Son, Chicago, Ill.
Laidlaw-Dunn-Gordon Co., Cincinnati, Ohio.
Lane & Bodley Co., Cincinnati, Ohio.
Walburn-Swenson Co., Chicago, Ill.

Contractors' Supplies.

Bucyrus Steam Shovel and Dredge Co., S. Milwaukee, Wis.
Contractors' Plant Mfg. Co., Buffalo, N. Y.
R. J. & A. B. Cram, Detroit, Mich.
Fairbanks, Morse & Co., Chicago, Ill.
Jeffrey Mfg. Co., Columbus, Ohio.
Lawrence Cement Co., 67 William St., N. Y.
Link Belt Engineering Co., Phila., Pa.
J. S. Mundy, Newark, N. J.
Pelham Machine Works, 416 W. 26th St., N. Y.
Stow Flexible Shaft Co., Ltd., Philadelphia, Pa.
Stow Manufacturing Co., Binghamton, N. Y.
Vulcan Iron Works, Toledo, Ohio.

Conveying Machinery.

Frick Company, Waynesboro, Pa.
C. W. Hunt Co., 45 Broadway, N. Y.
Jeffrey Mfg. Co., Columbus, O.
John A. Roebling's Sons Co., Trenton, N. J.
Lane & Bodley Co., Cincinnati, Ohio.
Link Belt Engineering Co., Phila., Pa.
F. H. C. Mey Chain Belting Eng. Works, Buffalo, N.Y.
Pennsylvania Machine Co., Philadelphia, Pa.
Walburn-Swenson Co., Chicago, Ill.

Corliss Engines

Edw. P. Allis Co., Milwaukee, Wis.
Beckett Foundry and Machine Co., Arlington, N. J.
M. C. Bullock Mfg. Co., Chicago, Ill.
C. & G. Cooper Co., Mt. Vernon, Ohio.
Fishkill Landing Machine Co., Fishkill, N. Y.
Frick Company, Waynesboro, Pa.
Lane & Bodley Co., Cincinnati, Ohio.
Hooven, Owens & Rentschler Co., Hamilton, Ohio.
Robt. Wetherill & Co., Chester, Pa.

Corrugated Iron.

Berlin Iron Bridge Co., East Berlin, Conn.
Merchant & Co., Phila., Pa.
Niles Iron & Steel Roofing Co., Niles, Ohio.

Cranes.

Berlin Iron Bridge Co., East Berlin, Conn.
Bucyrus Steam Shovel and Dredge Co., S. Milwaukee, Wis.
Detroit Foundry Equipment Co., Detroit, Mich.
Edwin Harrington, Son & Co., Philadelphia, Pa.
Wm. Sellers & Co., Philadelphia, Pa.
Southwark Foundry and Machine Co., Phila., Pa.
Walburn-Swenson Co, Chicago, Ill.
Walker Manufacturing Co., Cleveland, Ohio.
R. D. Wood & Co., Philadelphia, Pa.

Crusher Plates.

Chrome Steel Works, Brooklyn, N. Y.

Crushers, Ore, Phosphate Rock.

Edw. P. Allis Co., Milwaukee, Wis.
Bradley Fertilizer Co., Boston, Mass.
Beckett Foundry and Machine Co., Arlington, N. J.
Frisbee-Lucop Mill Co., 145 Broadway, N. Y.
Gates Iron Works, Chicago, Ill.
Griffith & Wedge Co., Zanesville, Ohio.
Jeffrey Mfg. Co., Columbus, Ohio.
Chrome Steel Works, Brooklyn, N. Y.
Geo. T. McLauthlin & Co., Boston, Mass.
Sturtevant Mill Co., Boston, Mass.
Walburn-Swenson Co., Chicago, Ill.

Cupolas.
Detroit Foundry Equipment Co., Detroit, Mich.

Damper Regulators.
Mason Regulator Co., Boston, Mass.
Standard Thermometer Co., Peabody, Mass.

Desks.
A. H. Andrews & Co., Chicago, Ill.

Diamond Drills.
American Well Works, Aurora, Ill.
M. C. Bullock Mfg. Co., Chicago, Ill.
Ingersoll-Sergeant Drill Co., 10 Park Pl., N.Y.
Sullivan Machinery Co., Chicago, Ill.
Rand Drill Co., 23 Park Place, N. Y.

Dies and Die Forgings.
E. W. Bliss Co., Brooklyn, N. Y.
Crescent Steel Co., Pittsburgh, Pa.
Morse Twist Drill & Machine Co., New Bedford, Mass

Die and Drill Steel.
Crescent Steel Co., Pittsburgh, Pa.
Wm. Jessop & Sons, Limited, 91 John St., N. Y.
Chrome Steel Works, Brooklyn, N. Y.

Drawing Instruments.
Theo. Alteneder & Sons, Philadelphia, Pa.
Brandis Sons Co., Brooklyn, N. Y.
E. L. Deane, Holyoke, Mass.
F. Weber & Co., Philadelphia, Pa.

Drawing Presses.
E. W. Bliss Co., Brooklyn, N. Y.
Stiles & Parker Press Co., Brooklyn, N. Y.

Dredging Machines.
Bucyrus Steam Shovel & Dredge Co., S. Milwaukee, Wis.
J. S. Mundy, Newark, N. J.
Marion Steam Shovel Co., Marion, Ohio.
Robert Poole & Son Co., Baltimore, Md.
Vulcan Iron Works, Toledo, Ohio.

Drills, Rock and Coal.
American Well Works, Aurora, Ill.
M. C. Bullock Mfg. Co., Chicago, Ill.
General Electric Co., 44 Broad St., N. Y.
Ingersoll-Sergeant Drill Co., Cortlandt St., N. Y.
Jeffrey Mfg. Co., Columbus, Ohio.
Oil Well Supply Co., Pittsburgh, Pa.
Rand Drill Co., 23 Park Place, N. Y.
Sullivan Machinery Co., Chicago, Ill.
Walburn-Swenson Co., Chicago, Ill.

Drilling Machines.
John Becker Mfg. Co , Fitchburg, Mass.
W. F. & J. Barnes Co., Rockford, Ill.
Boynton & Plummer, Worcester, Mass.
Buffalo Forge Co., Buffalo, N. Y.
Cushman Chuck Co., Hartford, Conn.
Dwight Slate Machine Co., Hartford, Conn.
E. Horton & Son Co., Windsor Locks, Conn.
Lodge & Davis Machine Tool Co., Cincinnati, O.
Niles Tool Works, Hamilton, Ohio.
Pennsylvania Machine Co., Philadelphia, Pa.
Seneca Falls Mfg. Co., Seneca Falls, N. Y.
Stow Flexible Shaft Co., Ltd., Philadelphia, Pa.
Stow Manufacturing Co., Binghamton, N. Y.

Drop Forgings.
Billings & Spencer Co., Hartford, Conn.

Drop Presses.
E. W. Bliss Co., Brooklyn, N. Y.
Niagara Stamping and Tool Co., Buffalo, N.
Stiles & Parker Press Co., Brooklyn, N. Y.
Walker Manufacturing Co., Cleveland, Ohio.

Drying and Calcining Machines.
F. D. Cummer & Son Co., Cleveland, Ohio.

Dynamos.
Colburn Electric Mfg. Co., Fitchburg, Mass.
General Electric Co., 44 Broad St., N. Y.
Interior Conduit & Insulation Co., New York.
Jeffrey Mfg. Co., Columbus, Ohio.
Westinghouse Electric & Mfg. Co., Pittsburgh, Pa.

Electroplating and Electrotyping Machines.
Hanson & Van Winkle Co., 81 Liberty St., N. Y.

Electric Railway Supplies.
Colburn Electric Mfg. Co , Fitchburg, Mass.
General Electric Co., 44 Broad St., N. Y.
Westinghouse Electric & Mfg. Co., Pittsburgh, Pa.

Electrical Instruments.
Colburn Electric Mfg. Co., Fitchburg, Mass
General Electric Co., 44 Broad St., N. Y.
Interior Conduit & Insulation Co., New York.
Standard Thermometer Co., Peabody, Mass.
United Electric Improvement Co., Philadelphia, Pa.
Westinghouse Electric & Mfg. Co., Pittsburgh, Pa.
Weston Electrical Instrument Co., Newark, N. J.

Electrical Rubber Goods.
Home Rubber Co., Trenton, N. J.
Newton Rubber Works, Boston, Mass.
Spinney, Virtue & Co., Lynn, Mass.

Elevators, Steam, Hydraulic, Electric.
S. Norris Craven & Co., Philadelphia, Pa.
Graves Elevator Co., Rochester, N. Y.
Geo. T. McLauthlin & Co., Boston, Mass.
Morse, Williams & Co., Philadelphia, Pa.
Springfield Foundry Co., Springfield, Mass.
Thos. G. Laney, Lima, Ohio.
Lane & Bodley Co., Cincinnati, Ohio.

Emery Wheels.
Pennsylvania Machine Co., Philadelphia, Pa.
Tanite Co., Stroudsburg, Pa.

Emery Wheel Machinery.
Pennsylvania Machine Co., Philadelphia, Pa.
Stow Flexible Shaft Co., Ltd., Philadelphia, Pa.

Engineering Instruments.
Theo. Alteneder & Sons, Brooklyn, N. Y.
Brandis Sons Co., Brooklyn, N. Y.
F. Weber & Co., Philadelphia, Pa.

Engines, Blowing.
Edw. P. Allis Co., Milwaukee, Wis.
Connersville Blower Co., Connersville, Ind.
Cooke & Co., 163 Washington St., N. Y.
P. H. & F. M. Roots Co., Connersville, Ind.
B. F. Sturtevant Co., Boston, Mass.
Southwark Foundry and Machine Co., Phila., Pa.
Walker Manufacturing Co., Cleveland, Ohio.

Engines, Gas, Gasoline, and Petroleum.
Otto Gas Engine Works, Philadelphia, Pa.
Pennsylvania Machine Co., Philadelphia, Pa.

Engines, Marine.
Atlantic Works, East Boston, Mass.
Shipman Engine Co., Boston, Mass.

Engines, Portable.
Griffith & Wedge Co., Zanesville, Ohio.

Engines, Stationary.
Edw. P. Allis Co., Milwaukee, Wis.
Ball & Wood Co., 15 Cortlandt St., New York.
Beckett Foundry and Machine Co., Arlington, N. J.
Buffalo Forge Co., Buffalo, N. Y.
M. C. Bullock Mfg. Co., Chicago, Ill.
Cooke & Co., 163 Washington St., N. Y.
C. & G. Cooper Co., Mt. Vernon, Ohio.
Fairbanks, Morse & Co., Chicago, Ill.
Fishkill Landing Machine Co., Fishkill, N. Y.
Frick Company, Waynesboro, Pa.
Hooven, Owens & Rentschler Co., Hamilton, Ohio.
Houston, Stanwood & Gamble, Cincinnati, Ohio.
Lane & Bodley Co., Cincinnati, Ohio.
Geo. T. McLauthlin & Co., Boston, Mass.
Oil Well Supply Co., Pittsburgh, Pa.
Pennsylvania Machine Co., Philadelphia, Pa.
Shipman Engine Co., Boston, Mass.
Southwark Foundry and Machine Co., Phila., Pa.
Stearns Manufacturing Co., Erie, Pa.
B. F. Sturtevant Co., Boston, Mass.
Robert Wetherill & Co., Chester, Penn.

Excavators.
Bucyrus Steam Shovel and Dredge Co., S. Milwaukee, Wis.
Jeffrey Mfg. Co., Columbus, Ohio.
Marion Steam Shovel Co., Marion, Ohio.
Vulcan Iron Works, Toledo, Ohio.

Fans, Ventilating.
Buffalo Forge Co., Buffalo, N. Y.
M. C. Bullock Mfg. Co., Chicago, Ill.

Feed-Water Heaters.

Wm. Baragwanath & Son, Chicago.
Edw. P. Allis Co., Milwaukee, Wis.
Fairbanks, Morse & Co., Chicago, Ill.
National Pipe Bending Co., New Haven, Conn.
Pennsylvania Machine Co., Philadelphia, Pa.
Robt. Wetherill & Co., Chester, Pa.
Goubert Mfg. Co., 32 Cortlandt St., N. Y.

Fertilizer Machinery.

Bradley Fertilizer Co., Boston, Mass.
Jeffrey Mfg. Co., Columbus, Ohio.
Robert Poole & Son Co., Baltimore, Md.
Walburn-Swenson Co., Chicago, Ill.

Filter Presses.

Walburn-Swenson Co., Chicago, Ill.

Fire Arms.

J. Stevens Arms & Tool Co., Chicopee Falls, Mass.

Fireproof Building Material.

Central Expanded Metal Co., Pittsburgh, Pa.
Berlin Iron Bridge Co., East Berlin, Conn.
Fred F. Bischoff & Co., Chicago, Ill.
Edward Darby & Sons, Philadelphia, Pa.
Empire Fire Proofing Co., Pittsburgh, Pa.
Kinnear & Gager Co., Columbus, Ohio.
Geo. T. McLauthlin & Co., Boston, Mass.
Niles Iron & Steel Roofing Co., Niles, Ohio.
Pioneer Fireproof Construction Co., Chicago, Ill.

Flexible Shafts.

Stow Flexible Shaft Co., Ltd., Philadelphia, Pa.
Stow Manufacturing Co., Binghamton, N. Y.

Flour Mill Machinery.

Edw. P. Allis Co., Milwaukee, Wis.
Dayton Globe Iron Works Co., Dayton, Ohio.
Robert Poole & Son Co., Baltimore, Md.

Flumes.

Rodney Hunt Machine Co., Orange, Mass.

Fly Wheels.

Edw. P. Allis Co., Milwaukee, Wis.
Lane & Bodley Co., Cincinnati, Ohio.
Robert Poole & Son Co., Baltimore, Md.
Walker Manufacturing Co., Cleveland, Ohio.

Forges.

Buffalo Forge Co., Buffalo, N. Y.
Cooke & Co., 163 Washington St., N. Y.
Pennsylvania Machine Co., Philadelphia, Pa.
B. F. Sturtevant Co., Boston, Mass.

Foot and Hand Presses.

E. W. Bliss Co., Brooklyn, N. Y.
Stiles & Parker Press Co., Brooklyn, N. Y.

Foundry Equipment.

Detroit Foundry Equipment Co., Detroit, Mich.
Walburn-Swenson Co., Chicago, Ill.

Forgings.

Billings & Spencer Co., Hartford, Conn.
Crescent Steel Co., Pittsburgh, Pa.

Furnace Builders.

Griffith & Wedge Co., Zanesville, Ohio.
Julian Kennedy, Pittsburgh, Pa.
Walburn-Swenson Co., Chicago, Ill.

Furniture and Chair Machinery.

Egan Co., Cincinnati, Ohio.
Fox Machine Co., Grand Rapids, Mich.
C. B. Rogers & Co., Norwich, Conn.

Gas Works Machinery.

Continental Iron Works, Brooklyn, N. Y.
R. D. Wood & Co., Philadelphia, Pa.

Gaskets, Copper.

U. S. Mineral Wool Co., 2 Cortlandt St., N. Y.

Gate Valves.

Chapman Valve Mfg. Co., Indian Orchard, Mass.
Continental Iron Works, Brooklyn, N. Y.
Lukenheimer Co., Cincinnati, Ohio.
Pancoast & Rogers, 22 Platt St., New York.

Gauges, Steam.

Crosby Steam Gage and Valve Co., Boston, Mass.
Standard Thermometer Co., Peabody, Mass.

Gear Cutters.

E. Horton & Son Co., Windsor Locks, Conn.
E. W. Bliss Co., Brooklyn, N. Y.
Pennsylvania Machine Co., Philadelphia, Pa.
Standard Tool Co., Cleveland, Ohio.
Stiles & Parker Press Co., Brooklyn, N. Y.
Walker Manufacturing Co., Cleveland, Ohio.
D. E. Whiton Machine Co., New London, Conn.

Gearing.

Edw. P. Allis Co., Milwaukee, Wis.
Dayton Globe Iron Works Co., Dayton, Ohio.
Fishkill Landing Machine Co., Fishkill, N. Y.
Griffith & Wedge Co., Zanesville, Ohio.
Lane & Bodley Co., Cincinnati, Ohio.
Robert Poole & Son Co., Baltimore, Md.
Stow Flexible Shaft Co., Ltd., Philadelphia, Pa.
Walker Manufacturing Co., Cleveland, Ohio.

Girders.

Berlin Iron Bridge Co., East Berlin, Conn.
Wrought Iron Bridge Co., Canton, Ohio.

Grain Elevator Machinery.

Edw. P. Allis Co., Milwaukee, Wis.
Jeffrey Mfg. Co., Columbus, Ohio.
Link Belt Engineering Co., Phila., Pa.
Robert Poole & Son Co., Baltimore, Md.
Walker Manufacturing Co., Cleveland, Ohio.

Grates and Hearths.

Samuel H. French & Co., Philadelphia, Pa.
Edwin A. Jackson & Bro., 50 Beekman St., N. Y.

Grates.

Vulcan Iron Works, Toledo, Ohio.

Grinding and Polishing Machinery.

Cleveland Twist Drill Co., Cleveland, Ohio.
Diamond Machine Co., Providence, R. I.
Lodge & Davis Machine Tool Co., Cincinnati, O.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Standard Tool Co., Cleveland, Ohio.
Stow Flexible Shaft Co., Ltd., Philadelphia, Pa.
Stow Manufacturing Co., Binghamton, N. Y.
Tanite Co., Stroudsburg, Pa.

Grips, Cable Railways.

Walker Manufacturing Co., Cleveland, Ohio.
Robt. Wetherill & Co., Chester, Pa.

Hangers.

SEE PULLEYS, ETC.

Hardware Manufacturers.

J. Stevens Arms & Tool Co., Chicopee Falls, Mass.

Heating and Ventilating Apparatus.

Buffalo Forge Co., Buffalo, N. Y.
Connersville Blower Co., Connersville, Ind.
Cooke & Co., 163 Washington St., N. Y.
P. H. & F. M. Roots Co., Connersville, Ind.
B. F. Sturtevant Co., Boston, Mass.

Heaters, Steam and Hot Water.

Boynton Furnace Co., 207 Water St., New York.
New York Central Iron Works Co., Geneva, N. Y.
J. F. Pease Furnace Co., Syracuse, N. Y.
H. B. Smith Co., 137 Center St., N. Y.
United States Heater Co., Detroit, Mich.
S. Wilks Mfg. Co., Chicago, Ill.

Hoisting Engines and Machinery.

Edw. P. Allis Co., Milwaukee, Wis.
Beckett Foundry and Machine Co., Arlington, N. J.
M. C. Bullock Mfg. Co., Chicago, Ill.
John F. Byers Machine Co., Ravenna, Ohio.
Cooper, Hewitt & Co., 17 Burling Slip, N. Y.
Contractors' Plant Mfg. Co., Buffalo, N. Y.
Fairbanks, Morse & Co., Chicago, Ill.
Griffith & Wedge Co., Zanesville, Ohio.
Edwin Harrington, Son & Co., Philadelphia, Pa.
C. W. Hunt Co., 45 Broadway, N. Y.
Jeffrey Mfg. Co., Columbus, Ohio.
Volney W. Mason & Co., Providence, R. I.
Moore Mfg. & Foundry Co., Milwaukee, Wis.
J. S. Mundy, Newark, N. J.
Pelham Machine Works, 416 W. 26th St., N. Y.
Sullivan Machinery Co., Chicago, Ill.
Trenton Iron Co., Trenton, N. J.
Walker Manufacturing Co., Cleveland, Ohio.

Hod Hoisting Machinery.

Pelham Machine Works, 416 W. 26th St., N. Y.

Hollow Bricks.

Empire Fire-Proofing Co., Pittsburgh, Pa.
Pioneer Fireproof Construction Co., Chicago, Ill.

Hose, Steam and Fire.

Boston Woven Hose & Rubber Co., Boston, Mass.
Crosby Steam Gage and Valve Co., Boston, Mass.
Home Rubber Co., Trenton, N. J.
Peerless Rubber Mfg. Co., 15 Warren St., N. Y.

Hydraulic Cement.

Lawrence Cement Co., 67 William St., N. Y.

Hydraulic Machinery.

Watson & Stillman, 204 E. 43d St., N. Y.
R. D. Wood & Co., Philadelphia, Pa.

Ice-Making Machinery.

Frick Company, Waynesboro, Pa.

Indicators, Steam-Engine.

Crosby Steam Gage and Valve Co., Boston, Mass.

Injectors.

Wm. Sellers & Co., Philadelphia, Pa.
Sherwood Mfg. Co., Buffalo, N. Y.

Industrial Railways.

C. W. Hunt Co., 45 Broadway, N. Y.

Insulated Wire.

Eastern Electric Cable Co., Boston, Mass.
Merchant & Co., Philadelphia, Pa.
The Okonite Co., Limited, 13 Park Row, N. Y.

Iron Working Machinery.

E. W. Bliss Co., Brooklyn, N. Y.
W. F. & J. Barnes Co., Rockford, Ill.
John Becker Mfg. Co., Fitchburg, Mass.
Billings & Spencer Co., Hartford, Conn.
Cushman Chuck Co., Hartford, Conn.
Dwight Slate Machine Co., Hartford, Conn.
Fox Machine Co., Grand Rapids, Mich.
Edwin Harrington, Son & Co., Philadelphia, Pa.
Hendey Machine Co., Torrington, Conn.
E. Horton & Son Co., Windsor Locks, Conn.
Jones & Lamson Mch. Co., Springfield, Vt.
Lodge & Davis Machine Tool Co., Cincinnati, O.
Long & Allstatter Co., Hamilton, Ohio.
Niles Tool Works, Hamilton, Ohio.
Pennsylvania Machine Co., Philadelphia, Pa.
Wm. Sellers & Co., Philadelphia, Pa.
Seneca Falls Mfg. Co., Seneca Falls, N. Y.
Stow Flexible Shaft Co., Ltd., Philadelphia, Pa.
Stow Manufacturing Co., Binghamton, N. Y.
Stiles & Parker Press Co., Brooklyn, N. Y.
Walker Manufacturing Co., Cleveland, Ohio.
D. E. Whiton Machine Co., New London, Conn.

Joists, Iron and Steel.

Berlin Iron Bridge Co., East Berlin, Conn.

Ladles.

Detroit Foundry Equipment Co., Detroit, Mich.

Lathes.

E. W. Bliss Co., Brooklyn, N. Y.
W. F. & J. Barnes Co., Rockford, Ill.
Edwin Harrington, Son & Co., Philadelphia, Pa.
Hendey Machine Co., Torrington, Conn.
Jones & Lamson Mch. Co., Springfield, Vt.
Niles Tool Works, Hamilton, Ohio.
Pennsylvania Machine Co., Philadelphia, Pa.
Wm. Sellers & Co., Philadelphia, Pa.
Seneca Falls Mfg. Co., Seneca Falls, N. Y.
Stiles & Parker Press Co., Brooklyn, N. Y.

Lamps, Electric.

Westinghouse Electric & Mfg. Co., Pittsburgh, Pa.

Locomotives.

Baldwin Locomotive Works, Philadelphia, Pa.

Locomotive Brakes.

Westinghouse Air Brake Co., Pittsburgh, Pa.

Lubricants.

Jos. Dixon Crucible Co., Jersey City, N. J.

Lubricators.

Lunkenheimer Co., Cincinnati, Ohio.
Wm. Powell Co., Cincinnati, Ohio.
Sherwood Mfg. Co., Buffalo, N. Y.

Machine Knives.

Fox Machine Co., Grand Rapids, Mich.

Machine Screws, etc.

Worcester Machine Screw Co., Worcester, Mass.

Machine Tools and Supplies.

W. F. & J. Barnes Co., Rockford, Ill.
John Becker Mfg. Co., Fitchburg, Mass.
Billings & Spencer Co., Hartford, Conn.
Boynton & Plummer, Worcester, Mass.
Bridgeport Machine Tool Works, Bridgeport, Conn.
Cleveland Twist Drill Co., Cleveland, Ohio.
Cooke & Co., 163 Washington St., N. Y.
Cushman Chuck Co., Hartford, Conn.
Dwight Slate Machine Co., Hartford, Conn.
Egan Co., Cincinnati, Ohio.
Fox Machine Co., Grand Rapids, Mich.
Edwin Harrington, Son & Co., Philadelphia, Pa.
E. Horton & Son Co., Windsor Locks, Conn.
Hendey Machine Co., Torrington, Conn.
Jones & Lamson Mch. Co., Springfield, Vt.
Lodge & Davis Machine Tool Co., Cincinnati, O.
Long & Allstatter Co., Hamilton, Ohio.
Robert Poole & Son Co., Baltimore, Md.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Niles Tool Works, Hamilton, Ohio.
Pennsylvania Machine Co., Philadelphia, Pa.
C. B. Rogers & Co., Norwich, Conn.
Wm. Sellers & Co., Philadelphia, Pa.
Seneca Falls Mfg. Co., Seneca Falls, N. Y.
Standard Tool Co., Cleveland, Ohio.
J. Stevens Arms & Tool Co., Chicopee Falls, Mass.
Stow Flexible Shaft Co., Ltd., Philadelphia, Pa.
Stow Manufacturing Co., Binghamton, N. Y.
Walker Manufacturing Co., Cleveland, Ohio.
D. E. Whiton Machine Co., New London, Conn.

Mantels.

Samuel H. French & Co., Philadelphia, Pa.

Mathematical Instruments.

Theo. Alteneder & Sons, Philadelphia, Pa.
E. L. Deane, Holyoke, Mass.
F. Weber & Co., Philadelphia, Pa.

Merchant Steel.

Chester Steel Castings Co., Phila., Pa.
Crescent Steel Co., Pittsburgh, Pa.
Wm. Jessop & Sons, Limited, 91 John St., N.

Metal Separator.

Ezra Sawyer, Worcester, Mass.

Meters, Water.

Deane Steam Pump Co., Holyoke, Mass.

Milling Machines.

John Becker Mfg. Co., Fitchburg, Mass.
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Lodge & Davis Machine Tool Co., Cincinnati, O.

Mining Machinery.

American Well Works, Aurora, Ill.
Beckett Foundry and Machine Co., Arlington, N. J.
A. J. Beckley & Co., Meriden, Conn.
Bradley Fertilizer Co., Boston, Mass.
M. C. Bullock Mfg. Co., Chicago, Ill.
Chrome Steel Works, Brooklyn, N. Y.
A. S. Cameron Steam Pump Works, E. 23
Frisbee-Lucop Mill Co., 145 Broadway, N. Y.
Gates Iron Works, Chicago, Ill.
General Electric Co., 44 Broad St., N. Y.
Griffith & Wedge Co., Zanesville, Ohio.
Harrington & King, Perf. Co., Chicago, Ill.
Ingersoll-Sergeant Drill Co., Cortlandt St., N. Y.
Jeffery Mfg. Co., Columbus, Ohio.
Geo. T. McLauthlin & Co., Boston, Mass.
J. S. Mundy, Newark, N. J.
Rand Drill Co., 23 Park Place, N. Y.
Sturtevant Mill Co., Boston, Mass.
Sullivan Machinery Co., Chicago, Ill.
Trenton Iron Co., Trenton, N. J.
Walburn-Swenson Co., Chicago, Ill.
Waldo & Stout, Bridgeport, Conn.

Mining Screens.

Beckett Foundry and Machine Co., Arlington, N. J.
A. J. Beckley & Co., Meriden, Conn.
Harrington & King Perf. Co., Chicago, Ill.
Jeffrey Mfg. Co., Columbus, Ohio.
Ludlow-Saylor Wire Co., St. Louis, Mo.

Motors, Electric.

General Electric Co., 44 Broad St., N. Y.
Interior Conduit & Insulation Co., New York.
Jeffrey Mfg. Co., Columbus, Ohio.
Standard Thermometer Co., Peabody, Mass.
Westinghouse Electric & Mfg. Co., Pittsburgh, Pa.

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Home Rubber Co., Trenton, N. J.
Garlock Packing Co., Palmyra, N. Y.
Sherwood Mfg. Co., Buffalo, N. Y.
Peerless Rubber Mfg. Co., 15 Warren St., N. Y.
Watson & Stillman, 204 E. 43d St., N. Y.

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Walburn-Swenson Co., Chicago, Ill.

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Dayton Globe Iron Works, Dayton, Ohio.
Jeffrey Mfg. Co., Columbus, Ohio.
Lane & Bodley Co., Cincinnati, Ohio.
Moore & White Co., Philadelphia, Pa.
Walker Manufacturing Co., Cleveland, Ohio.
Robt. Wetherill & Co., Chester, Pa.

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Du Bois & Du Bois, Washington, D. C.
G. G. Turri & Co., Melbourne, Australia.
John A. Wiedersheim, Philadelphia, Pa.

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Fox Machine Co., Grand Rapids, Mich.

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Atlantic Works, East Boston, Mass.
Rodney Hunt Machine Co., Orange, Mass.

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Harrington & King, Perf. Co., Chicago, Ill.
Merchant & Co., Philadelphia, Pa.

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Watson & Stillman, 204 E. 43d St., N. Y.

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Boomer & Boschert Press Co., Syracuse, N. Y.
Watson & Stillman, 204 E. 43d St., N. Y.

Presses, Hydraulic.

Boomer & Boschert Press Co., Syracuse, N. Y.
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Walker Manufacturing Co., Cleveland, Ohio.
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Long & Allstatter Co., Cincinnati, Ohio.
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Pennsylvania Machine Co., Philadelphia, Pa.
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Walker Manufacturing Co., Cleveland, Ohio.
Watson & Stillman, 204 E. 43d St., N. Y.
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Jeffrey Mfg. Co., Columbus, Ohio.
Ludlow-Saylor Wire Co., St. Louis, Mo.

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Jones & Lamson Mch. Co., Springfield, Vt.
Niles Tool Works, Hamilton, Ohio.

Separators, Coal and Ore.

A. J. Beckley & Co., Meriden, Conn.
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Steamships and Tow Boats.

Atlantic Works, East Boston, Mass.

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Vulcan Iron Works, Toledo, Ohio.

Steam Traps.

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Steel Importers.

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Steel Manufacturers.

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Wm. Jessop & Sons, Limited, 91 John St., N. Y.
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Tanks, Iron.

Wm. Baragwanath & Son, Chicago, Ill.
Continental Iron Works, Brooklyn, N. Y.

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O. S. Kelly Co., Springfield, Ohio.

Tanks, Wood.

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C. W. Hunt Co., 45 Broadway, N. Y.

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Robt. Wetherill Co., Chester, Pa.
C. W. Hunt Co., 45 Broadway, N. Y.

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Detroit Foundry Equipment Co., Detroit, Mich.

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James Leffel & Co., Springfield, Ohio.
Robert Poole & Son Co., Baltimore, Md.
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Deane Steam Pump Co., Holyoke, Mass.
Guild & Garrison, Brooklyn, N. Y.

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Home Rubber Co., Trenton, N. J.
Lunkenheimer Co., Cincinnati, Ohio.
Sherwood Mfg. Co., Buffalo, N. Y.
Mason Regulator Co., Boston, Mass.
Pancoast & Rogers, 22 Platt St., New York.
Wm. Powell Co., Cincinnati, Ohio.
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Robert Poole & Son Co., Baltimore, Md.
Sturtevant Mill Co., Boston, Mass.
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Well Drilling Machinery.

American Well Works, Aurora, Ill.
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Walburn-Swenson Co., Chicago, Ill.

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Crescent Steel Co., Pittsburgh, Pa.
Ludlow-Saylor Wire Co., St. Louis, Mo.
Merchant & Co., Philadelphia, Pa.
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Edward Darby & Sons, Philadelphia, Pa.
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Phosphor-Bronze Smelting Co., Ltd., Phila., Pa.

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Phosphor-Bronze Smelting Co., Ltd., Phila., Pa.
Trenton Iron Co., Trenton, N. J.

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C. B. Rogers & Co., Norwich, Conn.
Stow Flexible Shaft Co., Ltd., Philadelphia, Pa.

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Marion Steam Shovel Co., Marion, Ohio.

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Atlantic Works, East Boston, Mass.

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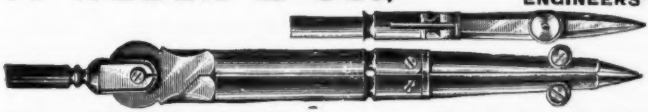

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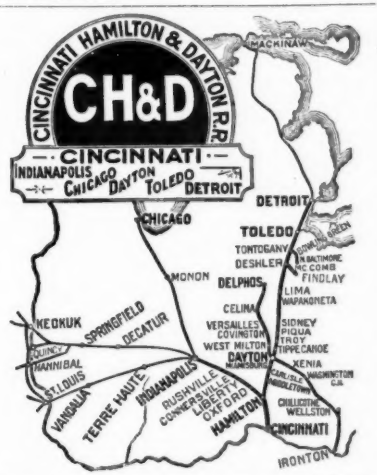

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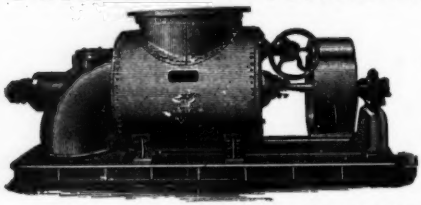

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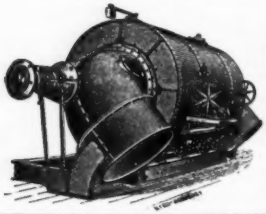

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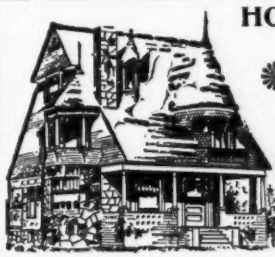

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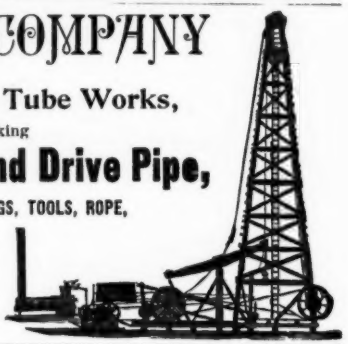

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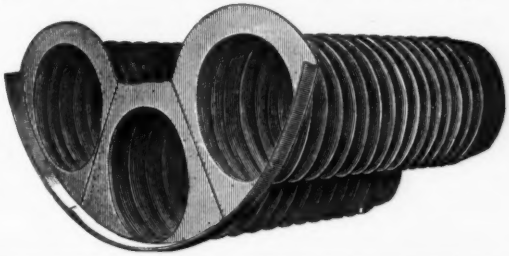

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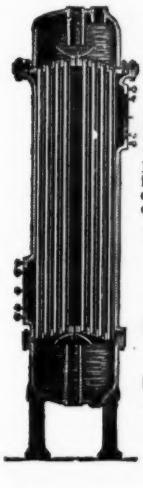

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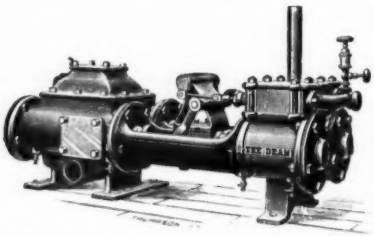

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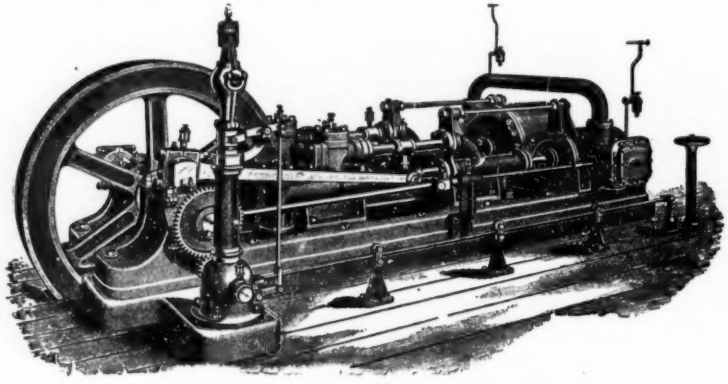

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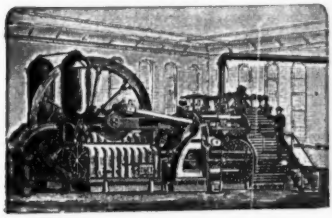

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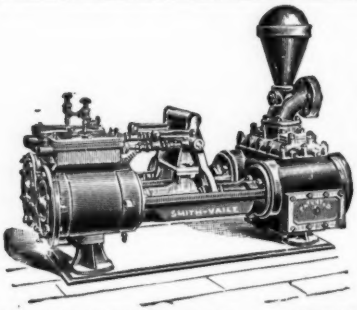

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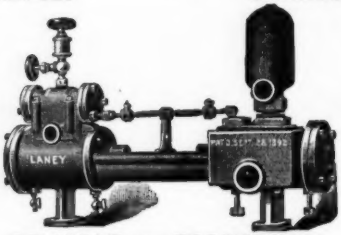

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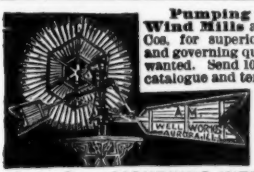

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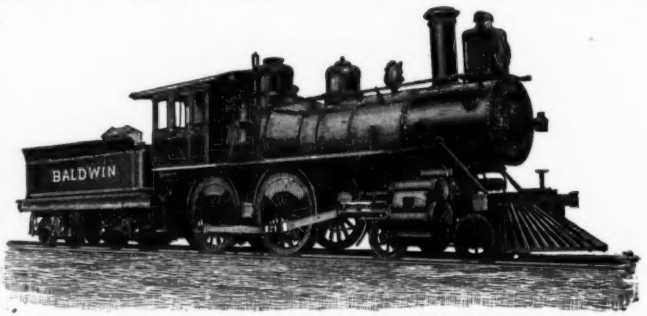

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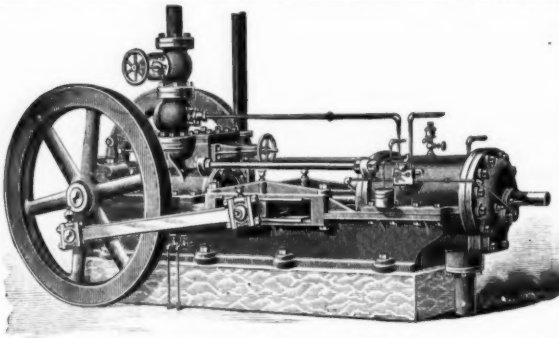
10,000 LOCOMOTIVES.

BESIDES REPAIRS FOR THE

350,000 Freight and Passenger Cars, and
26,000 Locomotives already equipped by

The Westinghouse Air-Brake Company.



MINING, TUNNELING and QUARRYING MACHINERY.

Straight Line, Compound and Duplex

AIR COMPRESSORS

FOR ALL PRESSURES.

ROCK DRILLS

GADDERS,

STONE CHANNELING MACHINES

Quarry Bars,

COAL MACHINES.

The value of labor-saving machinery is most pronounced and best appreciated when times are hard and money scarce. Rock Drills, Air Compressors, Coal Mining Machines, Stone Channeling Machines and all such appliances reduce the cost of production and save money. When business is dull it is a good time for reflection, and the best time to investigate labor-saving machinery. Take care that you buy the best, for in rock work it is surely the cheapest.

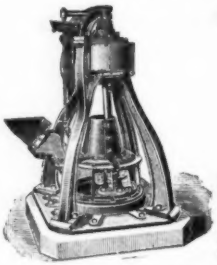
THE INGERSOLL-SERGEANT DRILL COMPANY,

HAVEMEYER BUILDING, 26 CORTLANDT ST., NEW YORK.

114a Queen Victoria St., London, E. C., England; 100-104 W. Washington St., Chicago, Ill.; 203 St. James St., Montreal, Canada; 201-203 Congress St., Boston, Mass.; 510 N. 4th St., St. Louis, Mo.; 26 S. Water St., Cleveland, O.

THE GRIFFIN MILL

The Only Perfect Pulverizer



Of QUARTZ, GOLD OR SILVER ORES, PLUMBAGO, PORTLAND CEMENT, PHOSPHATE ROCK, FOUNDRY FACINGS, And All Other Refractory Substances.

Will work either wet or dry, and deliver finished product. Capacity 3 to 4 tons per hour on Phosphate Rock, 1½ to 2 tons per hour on Portland Cement, Quartz or Ores, depending on hardness of material to be pulverized and fineness of product. Grinds from 30 to 250 Mesh with equal facility.

No Journals in Grinding Chamber. Ball rigid on shaft having direct positive action on material. Minimum power produces maximum amount of product. It is absolutely guaranteed in every respect, both as to construction and capacity. First cost, wear, and operating expense much less than stamp mills. Large number of mills in use on different materials with positive success in every instance.

CORRESPONDENCE SOLICITED, AND ILLUSTRATED DESCRIPTIVE PAMPHLET FURNISHED ON APPLICATION TO

BRADLEY FERTILIZER CO., 92 State St., Boston, Mass.

PATENT ROCK EMERY MILL STONES

Made of BLOCKS of Emery usually set in bronze.

DURABLE.

Because Emery is HARDER than anything except the Diamond.

RAPID GRINDERS.

Because Emery CUTS all substances with unexampled rapidity and the Emery face never GLAZES; also, because they run so CONTINUOUSLY, requiring little attention.

ECONOMICAL.

Because not expensive, and they last as much longer than other stones as they surpass them in HARDNESS, and because they soon SAVE their COST in DRESSING, the Emery face never requiring it.—Always sharp.

Send for Circular to STURTEVANT MILL CO., Boston, Mass.

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DIAMOND PROSPECTING DRILL

The **DIAMOND DRILL** is invaluable for the preliminary testing or later development of mineral property. It bores to **any depth** at **any angle**, and removes a **solid core** or section showing the **location, thickness** and **quality** of the **mineral.**

THE QUICKEST, CHEAPEST & BEST METHOD OF PROSPECTING.
THE MOST ACCURATE & RELIABLE RESULTS.

Diamond Drills operated by Hand or Horse Power, Steam, Compressed Air or ELECTRICITY.

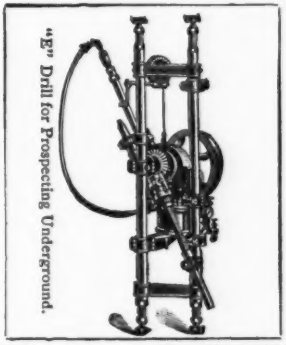
GENERAL QUARRYING MACHINERY — Channeling and Gadding Machines.

COAL MINING MACHINERY—The Stanley Entry Driving Machine.

Contractors for Prospecting Mineral Lands with the Diamond Core Drill.

SULLIVAN MACHINERY CO.,

54-60 N. Clinton St. CHICAGO, ILL. | 18 Broadway, NEW YORK. | 18th & Market St. DENVER.


"g" Drill for Prospecting Underground.

THE MAGIC CRUSHER

"I know them to excel all other machines, both in capacity and execution."

REDUCE REFRACTORY MATERIALS TO
NUT SIZE OR SIZE OF SAND. | IMPALPABLE POWDER OR COARSER GRADE.

GEO. T. McLAUTHLIN & CO., 120 Fulton St. BOSTON, MASS.

"No other method of pulverizing is comparable to this."

THE MAGIC PULVERIZER

JESSOP'S STEEL

For TOOLS, DRILLS, DIES, SAWS, &c.
ALL KINDS IN STOCK.
Gold Medal, Paris, 1889.

Highest Award, Chicago, 1893.

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W. F. WAGNER, Gen'l Manager.

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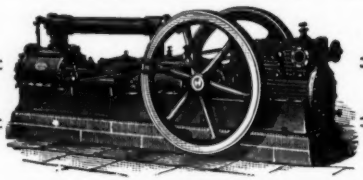
AIR AND GAS COMPRESSORS.

• • ALL • •



PRESSURES.

THE NORWALK IRON WORKS CO.

CIRCULARS. SOUTH NORWALK, CONN.

RAND DRILL COMPANY.

WE WERE AWARDED THE HIGHEST PREMIUM AT THE

World's Columbian Exposition

On our

Duplex Compound Steam and Compound Air Compressor,

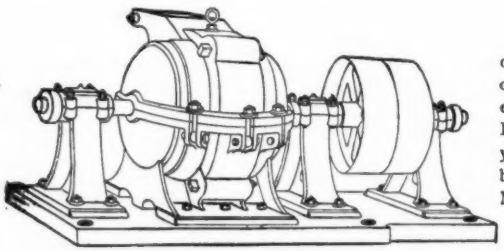
AT MACHINERY HALL,

And the following exhibited at Mines and Mining Bldg.:

HIGH PRESSURE COMPRESSOR,
STRAIGHT LINE COMPRESSOR,
LITTLE GIANT ROCK DRILL,
SLUGGER ROCK DRILL,
FURNACE TAPPING DRILL,
SHAFT BAR,
COLUMN,
DERBY BIT, and

AWARD on COLLECTIVE EXHIBIT of COMPRESSORS and DRILLS.

Rand Drill Company, 23 Park Place, N. Y.



For the reduction to fine powder of cement rock, fertilizers, ores and other substances, no machine equals in efficiency, durability and economy the Frisbee-Lucop Mill. Proved by seven years' continuous use. Mills on exhibition in this city. Frisbee-Lucop Mill Co., 136 Liberty St., New York.

DO YOU KNOW That it is an easy matter to keep yourself posted about ALL that is appearing in ALL the Technical Papers, English as well as American? See "The Technical Index" in this Magazine.

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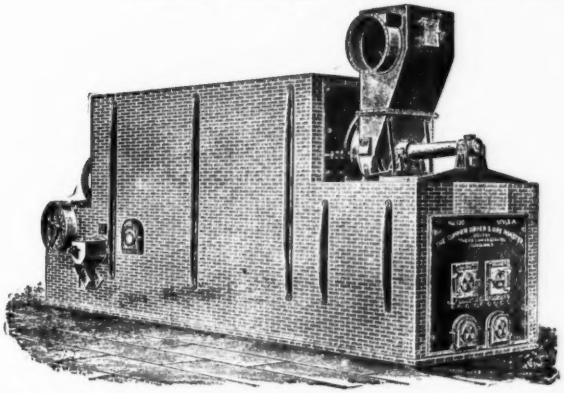
DRYER AND CALCINING APPARATUS

Five Styles of Dryers made, each in Six different sizes.



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Sand, Marl, Ores, Cement Mix, Salt, Phosphate, Clays, Infusorial Earth, Etc., Etc.

CALCINES

Ores, Paint Stocks, Phosphate, Gypsum, Etc., Etc.

The Cummer Dryers, Ore Roasters, Calciners, Processes, Hot Air Apparatus, Dry Kilns, Etc.

THE F. D. CUMMER & SON CO.,

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GATES ROCK and ORE BREAKER.

For Macadam, R. R. Ballast, Cranolithic, Concrete, Ores.

CAPACITY UP TO 200 TONS PER HOUR.

OVER 2,000 IN USE.

Improved Mining Machinery.

Catalogues and full information on application.

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A Complete and Very Useful Catalogue Free. Mention this Magazine.

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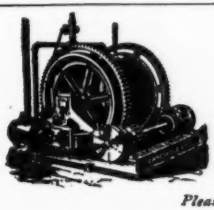

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Plans and Estimates for Machinery of First-Class Stamp Mills, Batteries, Amalgamating Pans, Settlers, Furnaces, Revolving Dry Kilns, Retorts, Clean-up Pans, Engines, Boilers, and Rock Breakers, Shafting, Pulleys, and Gearing.

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General Office and Works: HARRISBURG, PA., U. S. A.

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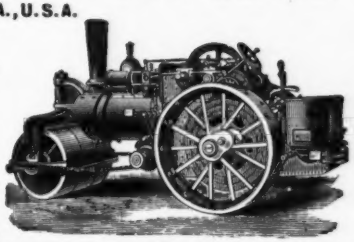
Not only a Roller, but a Road-Machine.



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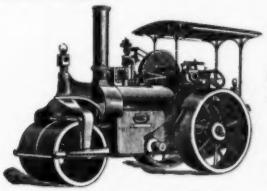
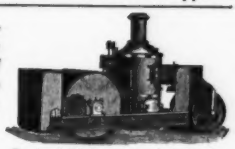


Springfield Steam Road Roller.

Steam Road Rollers, Steam Asphalt Rollers, Portable Heating Tanks, Street Contractors' Supplies.

Location at World's Fair Grounds, between Stock Pavilion and Agricultural Annex, on Road leading to Forestry and Dairy Building.



Springfield Steam Asphalt Roller.

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HOISTING ENGINES of any power and style. SINGLE AND DOUBLE CYLINDER, with improved patent friction drums especially adapted for all classes of work. Single and Double Drum, friction and direct geared, link motion MINING ENGINES. Four, six and eight spool, lock clutch, self-propelling BRIDGE ERECTING Engines. Double cylinder, double friction drum DOCK BUILDING and PILE DRIVING Engines. Quick motion, friction geared COAL HOISTING Engines. Powerful compound geared Reverse link motion and friction geared QUARRY and Haulage Engines. WITH OR WITHOUT BOILERS. Any amount of reference given. Established 1870.

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MANUFACTURERS OF
Improved Pattern HOISTING ENGINES and HOISTING MACHINERY
by Steam or by Electricity.
—FOR—
Mining, Excavating, Pile-Driving and General Hoisting Purposes.
of any Power and Style, Single and Double Cylinders, One, Two or more Drums.

With "Worn's" Improved Patent Friction Drums, especially adapted for Bridge or Dock Building, Pile-Driving, Coal Hoisting, Etc.

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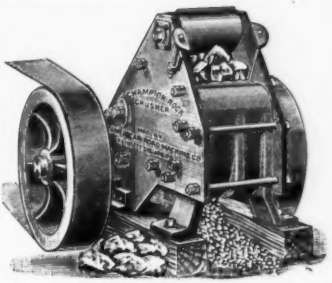

THE CHAMPION ROCK CRUSHER

is the first choice of all progressive road makers, engineers, contractors and R. R. ballast makers.

Catalogue is yours for the asking.

AMERICAN ROAD MACHINE CO., Kennett Square, Pa.

See Next Page.

A Point
In Advertising.

The novice in advertising—and especially the man who spends a little money now and then experimenting—will invariably judge the value of an advertising medium by the number of requests that it brings for a FREE circular. But this is short-sighted. Manifestly, it is CUSTOMERS you are after, not idle or curious requests for free catalogues. And hence, an advertisement which brings you a hundred such inquirers, but no sales, is worthless.

What you are after is business—and in the matter of *advertising which makes business*, here is some testimony well worth reading:

From F. D. CUMMER & SON CO., Drying Mach'ry, Cleveland, O.:
"We are pleased with the results we have received from our small card in THE ENGINEERING MAGAZINE, and although this is a very poor time (Dec. 27, 1893) to increase advertising expenses, we would feel like changing it to a quarter or a half page, if you can make us a satisfactory price. Let us hear from you."

The same firm, in a letter to FRASER & CHALMERS, Chicago:
"We look upon the money we have expended with THE ENGINEERING MAGAZINE as the best investment we have ever made in the advertising line, and from now on, will appear with a half page 'ad.'"

From GEORGE PEACOCK, Mining Cars, Selma, Ala.:
"Please send me a copy of THE ENGINEERING MAGAZINE. F. D. Cummer & Sons Co. say it is the best advertising medium they know of."

From THE KINNEAR & GAGER CO., Steel Ceilings, Columbus, O.:
"We have certainly had very satisfactory returns from THE ENGINEERING MAGAZINE, and we intend to increase our space with you shortly."

From BROOMELL, SCHMIDT & CO., Hot Water Heaters, York, Pa.:
"We are pleased to say that we have had quite a number of inquiries which refer to our advertisement in THE ENGINEERING MAGAZINE."

From BENJAMIN R. WESTERN, Advertising Expert, New York:
"You will be pleased to know that our clients are well satisfied with THE ENGINEERING MAGAZINE, as evidenced by the regularity with which their announcements appear. A consideration of the Magazine's constituency must satisfy any thinking advertiser of its paying qualities."

From WASHBURN-MOEN MFG. CO., Wire Mfrs., Worcester, Mass.:
"Our admiration for THE ENGINEERING MAGAZINE is probably quite up to that of any person you are in the habit of meeting, no matter how enthusiastic. It glows with substantial magnetism from one cover to the other, and is replete with just such information as the average first-class practical business man of to-day wants."

I could entertain you for an hour with voluntary and unsolicited testimony like this, but—enough! The Magazine speaks for itself.

I am always pleased to quote our terms.

Yours, for profit,

JOHN ROBERTSON, *Advertising Manager,*
The Engineering Magazine, New York.

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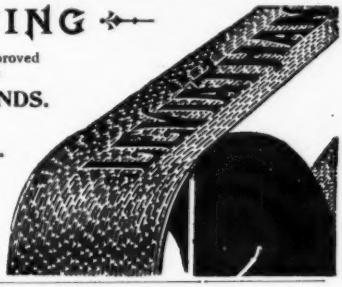
Tested under the hardest possible conditions and proved by years of service to be the best possible belt

FOR HEAVY DRIVING OF ALL KINDS.

Proof against Heat, Steam and Water.

Strength, Durability and Traction Power Unequalled.



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DO YOU KNOW THE VALUE OF

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We shall be glad to send you a pamphlet containing scientific and practical information of interest and value. It is sent free of cost with sample of graphite. **JOS. DIXON CRUCIBLE CO. JERSEY CITY, N. J.**

See Page Opposite.

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It will pay inventors and capitalists in *any part of the world* to make special and direct inquiries as to our rates for obtaining Patents in the above Colonies. Our facilities are *the very best*. All business can be promptly and accurately done by correspondence, our clients being found in all parts of the world. Inventors' interests carefully guarded. All correspondence confidential. During many years of practice we have secured some of the most valuable patents issued.

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LACQUERS FOR ALL PURPOSES

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LEONARD INTERLOCKING BLOCK SIGNALS.

(Applicable to any form of standard semaphore and using existing wires.)

LEONARD TRAIN ORDER SIGNALS.

(Operated by Train Dispatcher or Station Operator.)

INDIVIDUAL TELEGRAPH CALLS.

(Introduced into main line without delaying or affecting regular service.)

ALL WITH AUTOMATIC VERIFYING ANSWER-BACKS.

LUNDELL DYNAMOS AND MOTORS.

Iron-clad, Simple, Efficient, Durable.

Direct Current, Slow Speed.

IN SIZES UP TO 25 KILOWATTS.

Lundell Dynamos.

Lundell Motors.

Lundell Fan Motor Outfits.

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LUNDELL DYNAMOS DIRECTLY CONNECTED TO ANY TYPE OF HIGH SPEED ENGINES.

Plants Designed and Built by the

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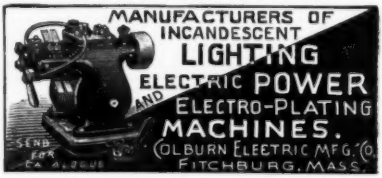

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May, 1891

July, 1891

and

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Address,

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DO YOU KNOW That it is an easy matter to keep yourself posted about ALL that is appearing in ALL the Technical Papers, English as well as American? See "The Technical Index" in this Magazine.

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For Mechanical and Electrical Purposes.

Works at Lynn, Mass., U. S. A.

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In Economical and Satisfactory Operation in several Plants in the United States.

THIS SYSTEM IS AN ABSOLUTE AND CONCRETE FACT. IT IS NOT A NEBULOUS PROMISE.

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401-407 SIBLEY ST., ST. PAUL, MINN.
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Garlock Packings.

PATENTED.

We especially invite the attention of parties in need of a High Grade Packing to the various articles which we manufacture. The Elastic Ring, Sectional, Spiral and Special Water Packings. Will not melt or blow out. Tested

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WITHOUT SEAM

The Latest Improvements in Rubber Belting.

Cannot Separate Between the Plies.

Equal Tension on All Stitches.

Cannot Break the Stitches in

Running Over Small Pulleys.

SEND FOR ILLUSTRATED PAMPHLET.

BOSTON WOVEN HOSE AND RUBBER CO.

BOSTON. CHICAGO. ST. LOUIS. SAN FRANCISCO.

THE NEWTON RUBBER WORKS.

BATTERY JARS MADE BY SPECIAL PROCESS.

Thoroughly Acid-Proof.

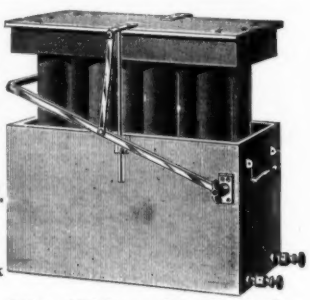
STRONGEST. LIGHTEST.

Salts cannot "creep."

EXCLUSIVE M'F'RS HEUSTIS PATENT BICYCLE TIRES.

Pneumatic and Cushion Tires, and Bicycle Pedals.

Hard and Soft Rubber Mould Work of all kinds.



Factory, Newton Upper Falls, Mass. Office, 178 Devonshire St., Boston.

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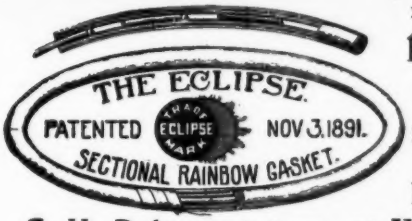

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Peerless Rubber M'f'g Company,

Patentees and Sole Manufacturers.

Two sizes—1/2 and 5/8. Fit any man hole or hand hole in the world · 3/8 for unions.

Rainbow Sheet and Flange Packing.

Peerless Piston and Valve Rod Packing.

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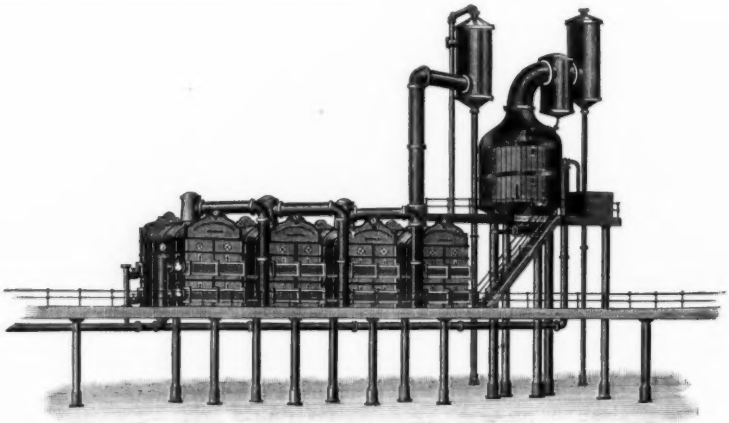

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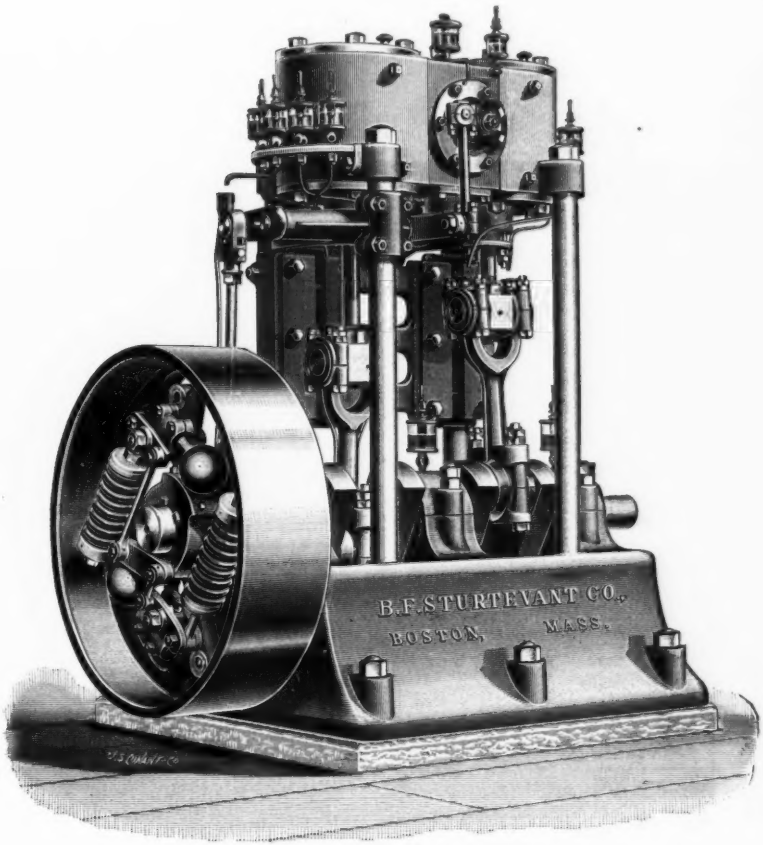

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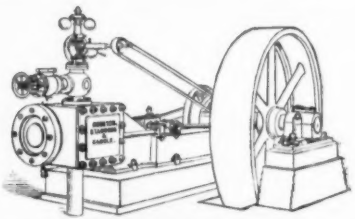

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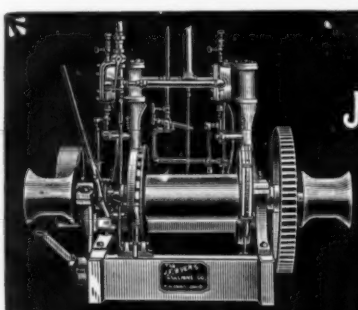

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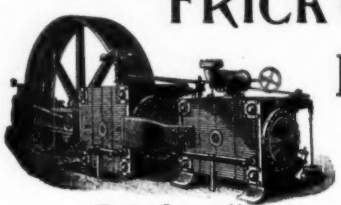

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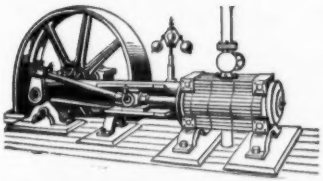

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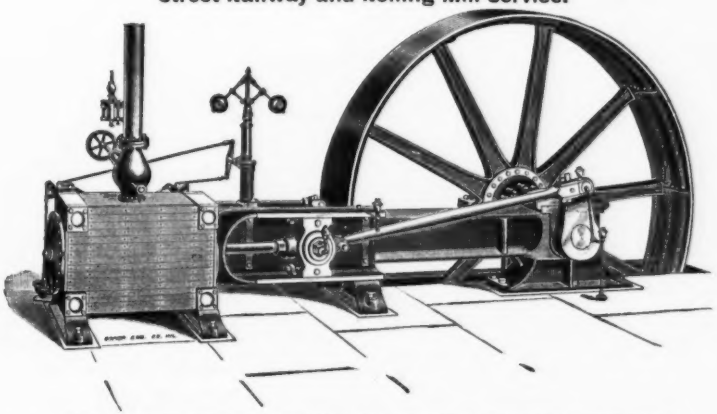

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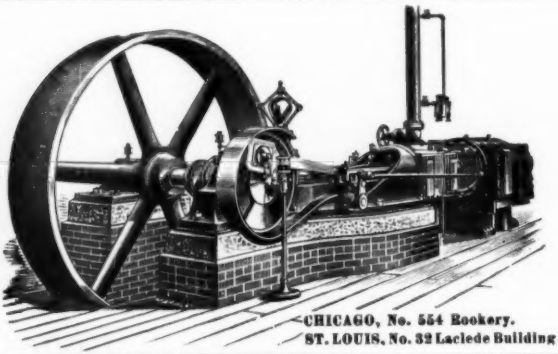

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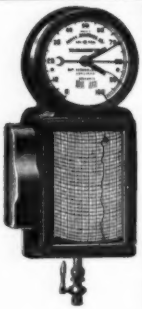

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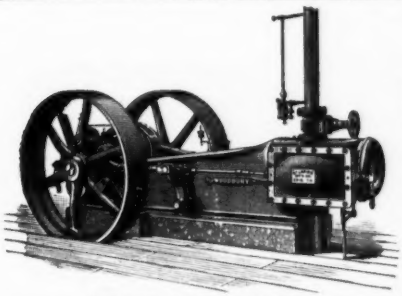

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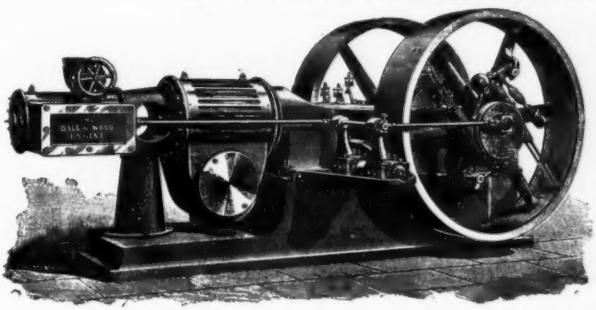

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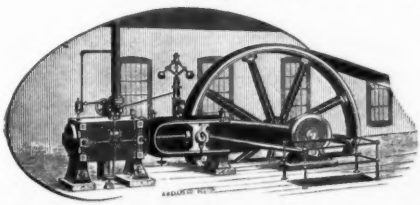

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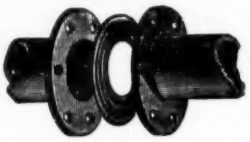

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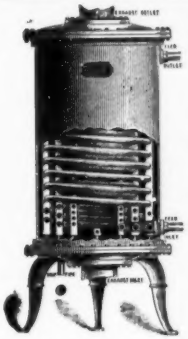

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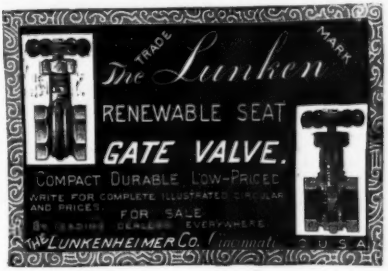

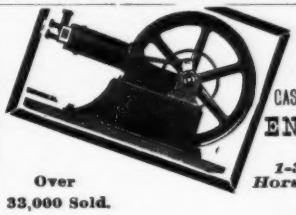

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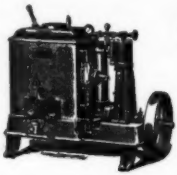

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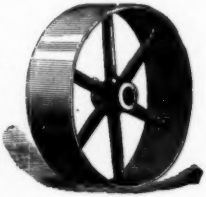

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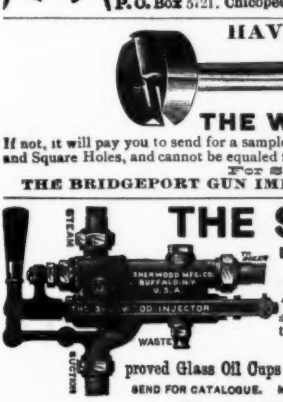

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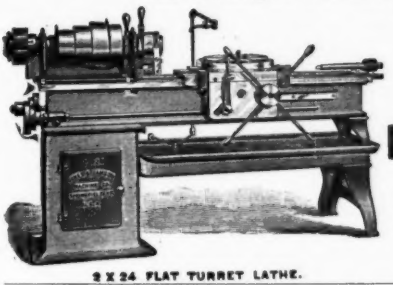

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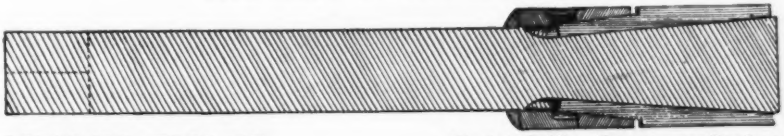

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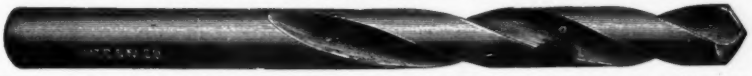

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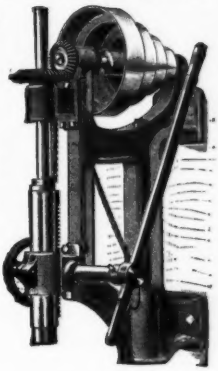

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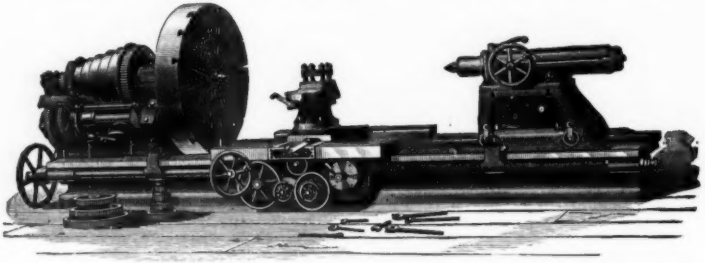

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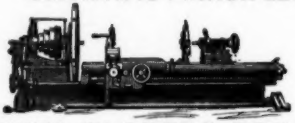

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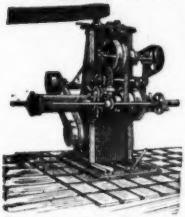

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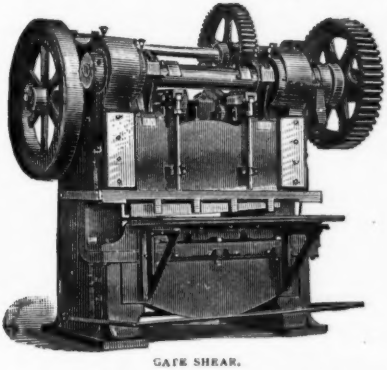

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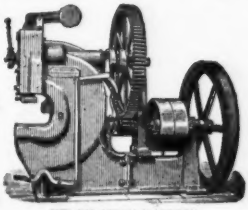

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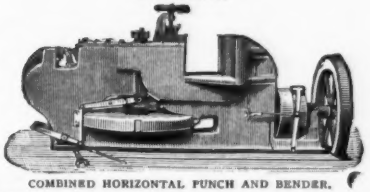

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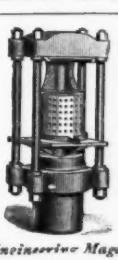

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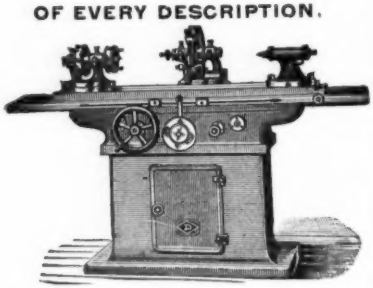

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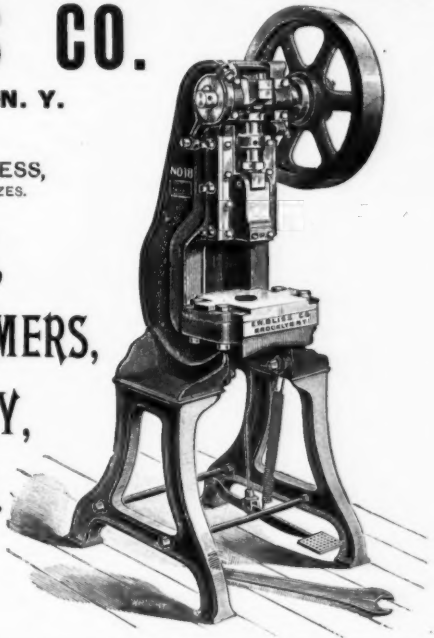

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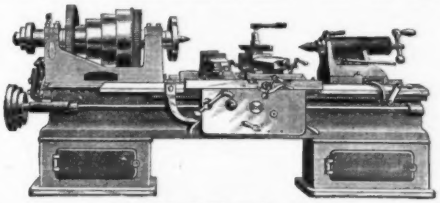

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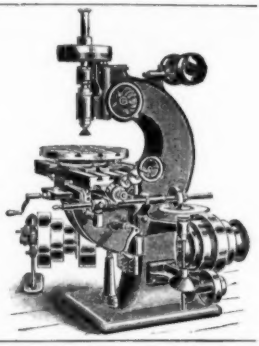

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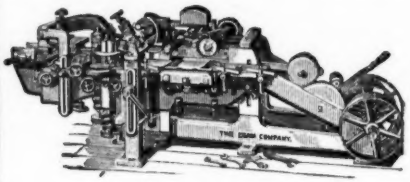

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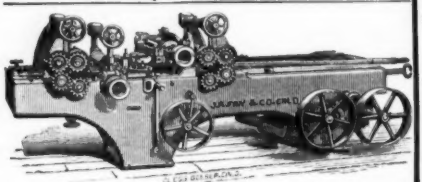

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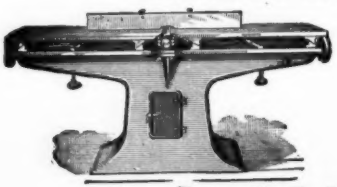

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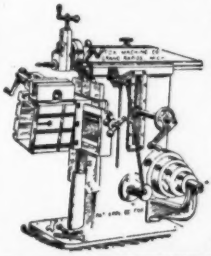

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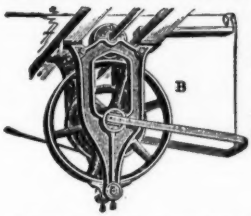

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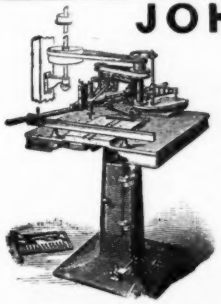

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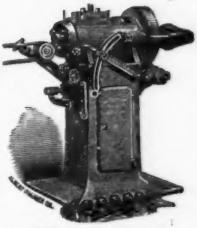

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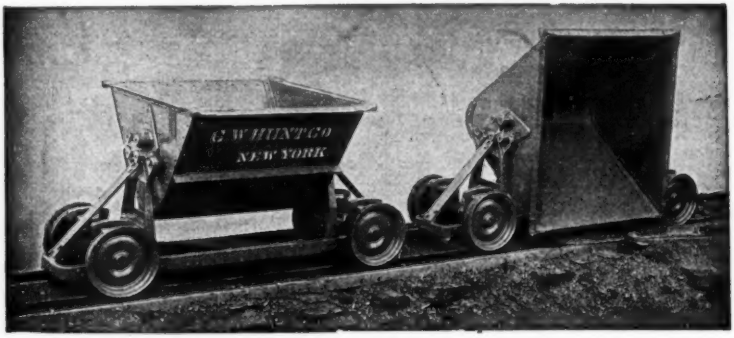

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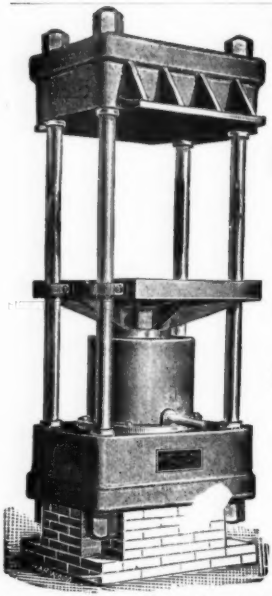

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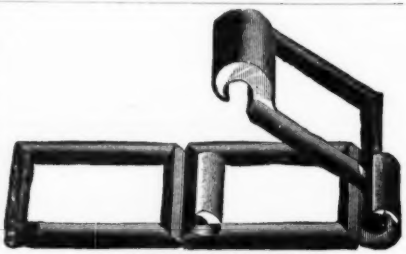

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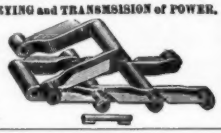

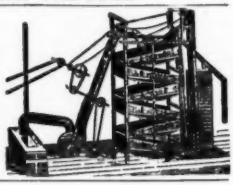

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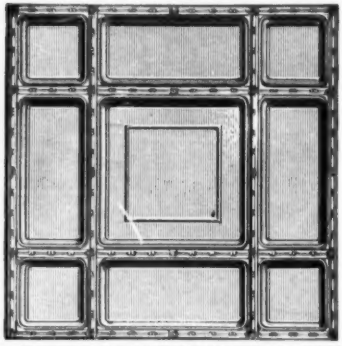

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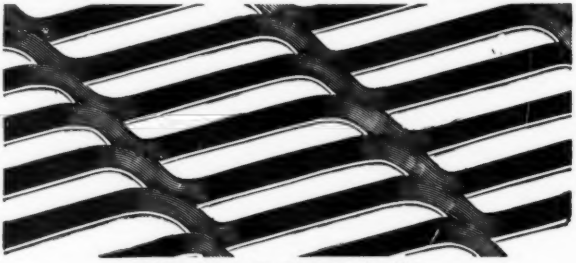

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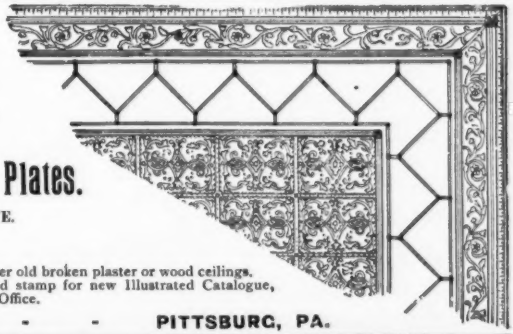

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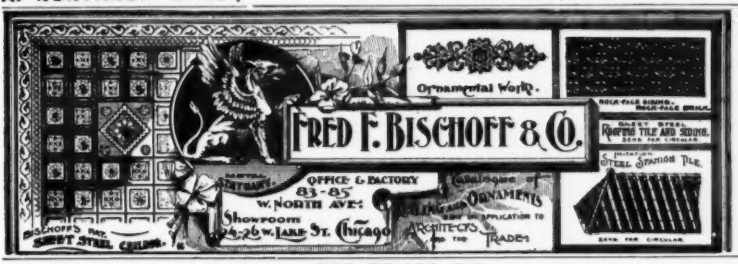

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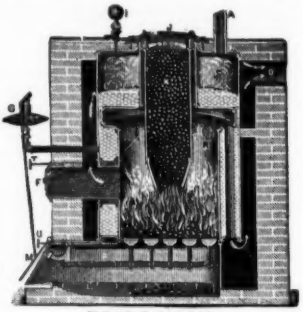

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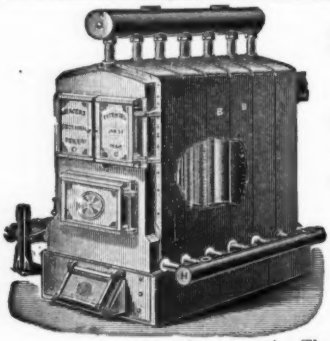

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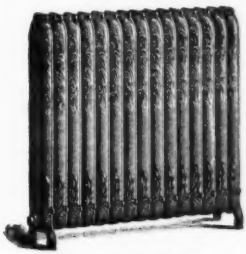

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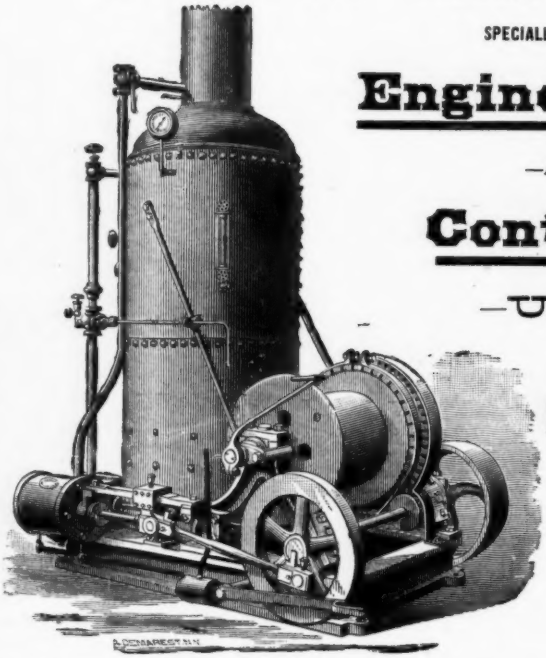

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